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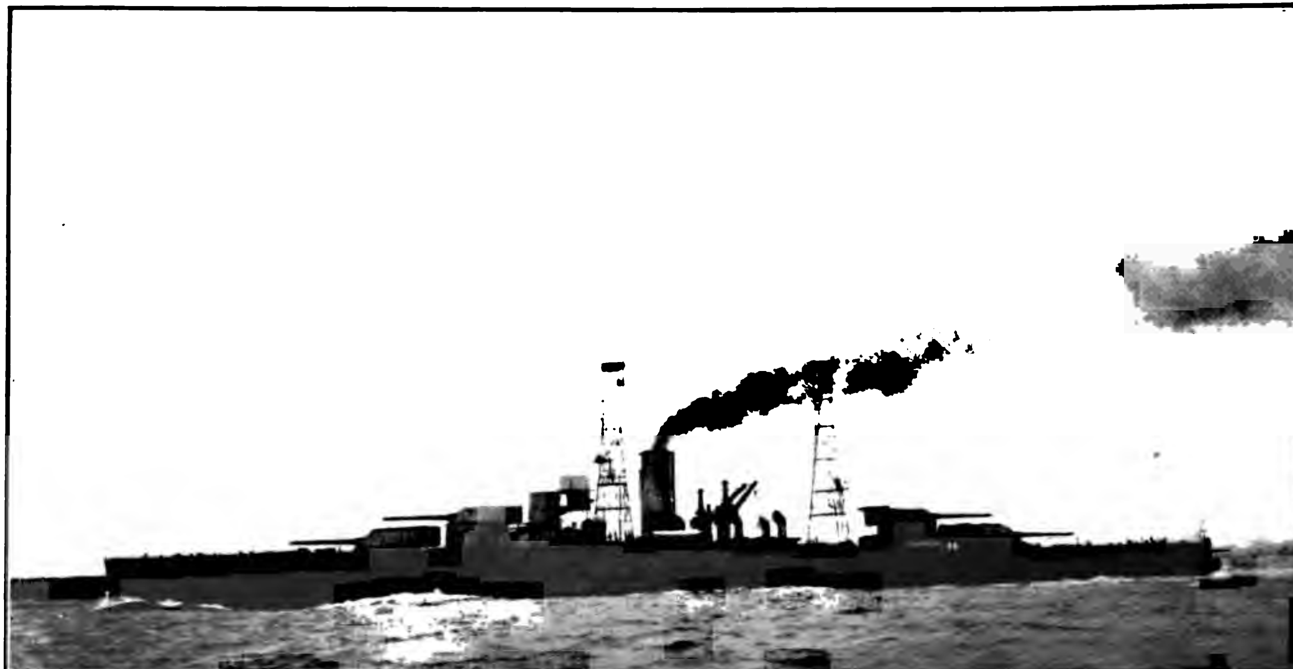
INDEX TO CURRENT MILITARY LITERATURE

It is announced that hereafter the "Supplement" to the JOURNAL OF THE UNITED STATES ARTILLERY—*Index to Current Military Literature*—will not be published.

There is being compiled, however, a card index of subjects of military interest appearing in the JOURNAL'S "exchanges." Those desiring references should address the Librarian, Coast Artillery School Library, Fort Monroe, Virginia.

Remittances received for *Index to Current Military Literature* will be credited subscribers on advance subscriptions to the JOURNAL OF THE UNITED STATES ARTILLERY.



Photograph by Boston Photo News Co. 1739

THE U. S. BATTLESHIP "NEVADA"

Completed January, 1915. Full load displacement, 28,400 tons; length (water line), 575 feet; beam, 95¼ feet; mean draught, 28½ feet; speed, 20.9 knots. Armament: ten 14-inch, twenty-one 5-inch, four 3-pdrs. (saluting), two 1 pdrs. Four 21-inch torpedo tubes, submerged. Complement, 863. (See page 100.)

# JOURNAL

OF THE

UNITED STATES ARTILLERY

VOL. 45, No. 1 JANUARY-FEBRUARY, 1916 WHOLE No. 137

THE USE OF HEAVY MOBILE ARTILLERY IN CONJUNCTION WITH OUR SEACOAST ARMAMENT

BY FIRST LIEUTENANT MEADE WILDRICK, COAST ARTILLERY CORPS

So far one of the greatest lessons learned in the present European war is the increased importance of heavy mobile artillery. To quote from the observations of a military observer on this point, we find the following:

> The experiences of this war have caused many profound modifications in the theories commonly held before the war broke out, but no factor was perhaps so underestimated as the effect of high explosive projectiles fired by large guns and howitzers. The successes of the Japanese at Port Arthur had given an inkling of the potentialities of the heavy howitzer against permanent fortifications, but the decisive effect of high explosives against troops in the field in well concealed intrenchments has come as a complete surprise. The gunner, and more especially the garrison gunner, has come into his own, for this arm of the service has assumed an importance greater probably than it had ever before possessed. It is extremely hard to conceal the position of trenches from an aerial observer, and once their position is notified to the guns and the exact range is obtained it is not long before the whole lengths of trenches will be blown in and entanglements, trous-de-loups, and every form of obstacle, however ingenious, swept away.

As yet our knowledge of the details of the mechanism and operation of these new engines of war is, for the most part, meagre and confused. Nevertheless, in case of war with a modern military power we must expect to be confronted in our military operations with hostile mortars and howitzers of large caliber and great destructive power. To offset this advantage it becomes necessary for us to take to heart the lessons taught and to devise some scheme whereby we can use effectively our own seacoast armament or any

other heavy mobile artillery that may be provided in the near future. Coast artillery troops are especially fitted for the service of heavy land batteries and can easily combine this service with their other military duties; being familiar with the technical problems connected with the operation and maintenance of heavy ordnance.

The object of this discussion is to supplement the article entitled "The Use of Our Seacoast Guns and Mortars in Land Defense," which appeared in the July-August issue of the JOURNAL OF THE U. S. ARTILLERY, and to discuss a system by which our coast artillery troops can be used not only to man the armament of our future seacoast defenses but also to serve any heavy land batteries that may soon be made part of our military establishment. The system to be described is especially adapted to the defense of important cities or other strategic points, such as New York, Washington, etc. It can also be applied to the service of heavy land artillery when operating with large bodies of mobile troops.

TYPE OF HOWITZER OR MORTAR

The type of howitzer or mortar most suited for this system can best be designed by the Ordnance Department which has the necessary specialists and the facilities to make a thorough study of this question. It might prove practical to design a mount for our present seacoast mortar which would make this weapon mobile and enable it to be easily transported and quickly mounted.

In Figs. 1 and 2 are shown pictures of the Skoda howitzer, the following details of which may be of interest. This is the Austrian howitzer that has played such an important part in the present war, having been used not only in reducing the Belgian forts but also those at Przemsyl. It has a caliber of 30.5 centimeters, and fires a projectile weighing 860 lbs. at muzzle velocity of 1115 f.s. The maximum range is 14,000 yards and it is very accurate. Its mobility is so great that it can be totally dismounted and placed on tractors in 40 minutes, thus offering little chance of capture. It is drawn by a Skoda-Daimler motor car of 100 h.p. with four driving wheels. Over ordinary roads it can travel at the rate of 12 miles per hour and at low speed can go up a 16 per cent grade. It can be mounted by means of winches on its carriage in 24 minutes. The effect of its shells on fortifications is tremendous.

Whatever the design, it should resemble in a general way that shown in Figs. 1 and 2 and fulfill the following requirements:

1. It should be mobile and capable of being quickly transported either by railroad on flat cars or by gasoline tractors over ordinary roads.

2. It should be able to be quickly mounted on a flat concrete emplacement of simple design.

FIG. 1. 1740

3. It should be more powerful than any similar weapon that could be brought against it. (For the purpose of the following discussion we will assume its maximum range as 20,000 yards.)

4. Last and most important, in addition to being equipped with the ordinary telescopic sights, it should be practicable to lay it for azimuth and range as is done with our present type of seacoast mortars.

Photograph by Boston Photo News Co.

FIG. 2.

1741

System as Applied to the Defense of a City or Other Strategic Point

For the purpose of illustration, let us assume the defense of a city represented in Fig. 3. Fort Blank is a seacoast fort of modern construction and equipment. The guns and mortars mounted therein can be used in repelling an attack

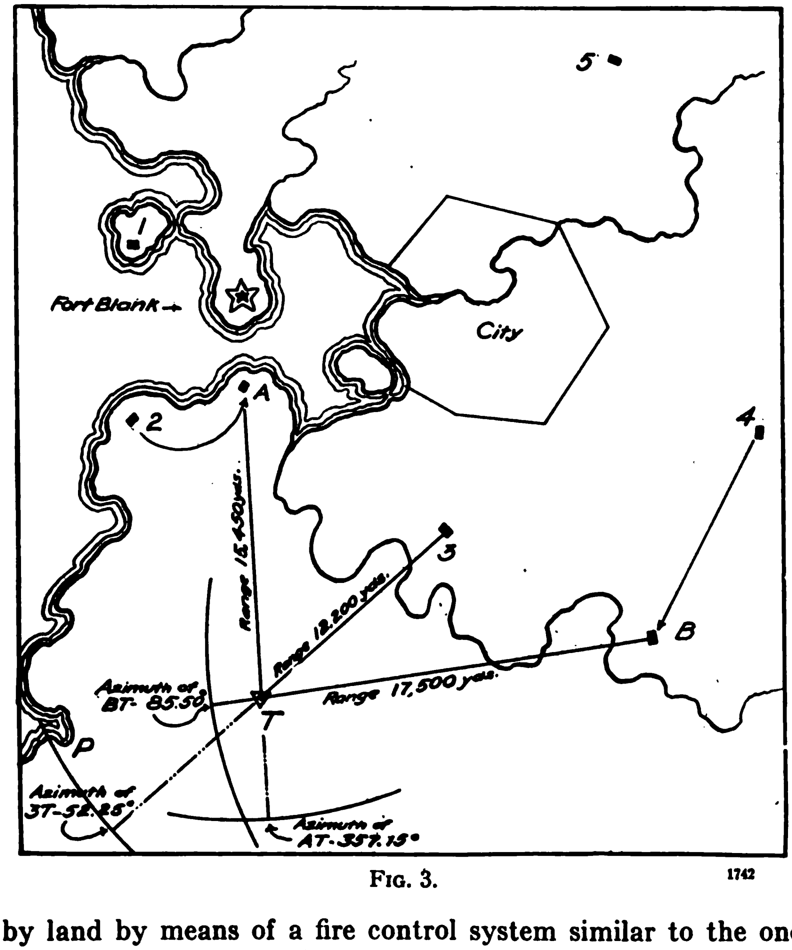


Fig. 3. 1742

by land by means of a fire control system similar to the one described in the following pages.* At points 1, 2, 3, 4, and 5 are built concrete emplacements to hold a 2-gun howitzer battery of the type previously described. The locations for these emplacements are carefully selected during peace and

* See also article entitled "The Use of Our Seacoast Guns and Mortars in Land Defense," Journal of the U. S. Artillery, July-August, 1915.

their position should as far as possible be kept a secret. Batteries 1 and 2 are emplaced for both sea and land defense and should be a part of the permanent armament of Fort Blank. Batteries 3, 4, and 5 are emplaced in rear of the land defense scheme for the city and are for land defense only. The howitzers for these emplacements would not be mounted except when the city represented in Fig. 3 is threatened by a land attack. The emplacements at points 3, 4, and 5 could either be built during peace or immediately upon the declaration of war. All the emplacements should be artificially concealed and made as invisible as possible to a hostile air scout. Similarly, the positions for these batteries should be added to the present land defense scheme for each important city or strategic point in our country and outlying possessions. The armament for these emplacements should be kept at centrally located depots from which it could be sent out by rail to any threatened point upon a moments notice. Each coast defense should be permanently equipped with one or more batteries of these howitzers to supplement the permanent armament of the forts, as batteries 1 and 2 in Fig. 3. They should be well concealed masked batteries and used not only to keep the enemy's ships at a greater distance from the permanent seacoast fortifications and mine fields, but also to be used against any heavy mobile siege artillery that may be landed by the enemy in attempting to reduce the seacoast defenses from the rear. Each Coast Artillery company of the regular service and of the National Guard should be required to have an annual land defense target practice with these howitzers, assuming conditions similar to those described in the following problems, in addition to a sea defense target practice similar to that conducted at present with our seacoast mortars. In case of war the country would then have an available reserve of trained officers and men familiar with the fire control and operation of these large howitzer batteries and ready to man the reserve batteries held at the central reserve depots as previously described. These reserve batteries could be immediately rushed to any threatened point, mounted, and within a few hours after their arrival be ready for any service. The number of batteries necessary to be held in reserve and also the most suitable points at which the reserve depots should be located, could be determined by a board of officers. As an enemy would not force a landing and threaten more than one or two

points along either coast at any one time, the guns at the other points and those held in reserve at central depots could be quickly sent to the threatened areas. Also if only one coast is attacked, the batteries on the other coast would be available for use. At the central depots the howitzers, their tractors, and reserve ammunition should be stored on flat cars ready for immediate service.

It has even been suggested to mount howitzers or mortars on a specially constructed railroad flat car, so that they could be fired directly from the railroad track. We have at present such a network of completed railroads and trolley lines all along our Atlantic seaboard from Maine to Florida, that there are only twenty or thirty miles of seacoast that could not be covered by guns mounted in this way. The fire of these guns could be controlled by maps similar to those described in the following pages. A system of this kind would undoubtedly prove of great value in resisting a sudden landing by force; due to its great mobility and destructive power.

Upon the declaration of war the emplacements previously described would be constructed, if not already built, and carefully concealed. The howitzers or mortars held at the central depots described above, with their tractors and ammunition, would be hastened to the threatened locality by special trains. As soon as they arrive at their destination, the howitzers should be drawn by their tractors to the previously prepared emplacements and quickly mounted. For example, let us assume that the city represented in Fig. 3 is the threatened area. The howitzers held at the nearest central depot are immediately shipped to the previously prepared emplacements at points 3, 4, and 5; the location of these emplacements having been selected in time of peace, well in rear of the line of resistance for the land defense scheme, and near good roads radiating from the city. If the exposed emplacement at 2 becomes untenable, the battery can be withdrawn to a more protected point at A. Similarly, the batteries placed at points 3, 4, and 5 can be moved by their tractors to any other points and mounted in new emplacements, as the ensuing tactical developments may require. Thus Battery 4 can be brought up to assist Battery 3 and be mounted in a new emplacement located at B.

System of Fire Control

The main requisite of the fire control system is an accurate

military map. A map should be made during peace of all areas in range of emplacements already built or contemplated to be built. The scale should be 3 inches = one mile, and all military details such as trees, fences, buildings, etc., should be so accurately represented on the map, that a scout should

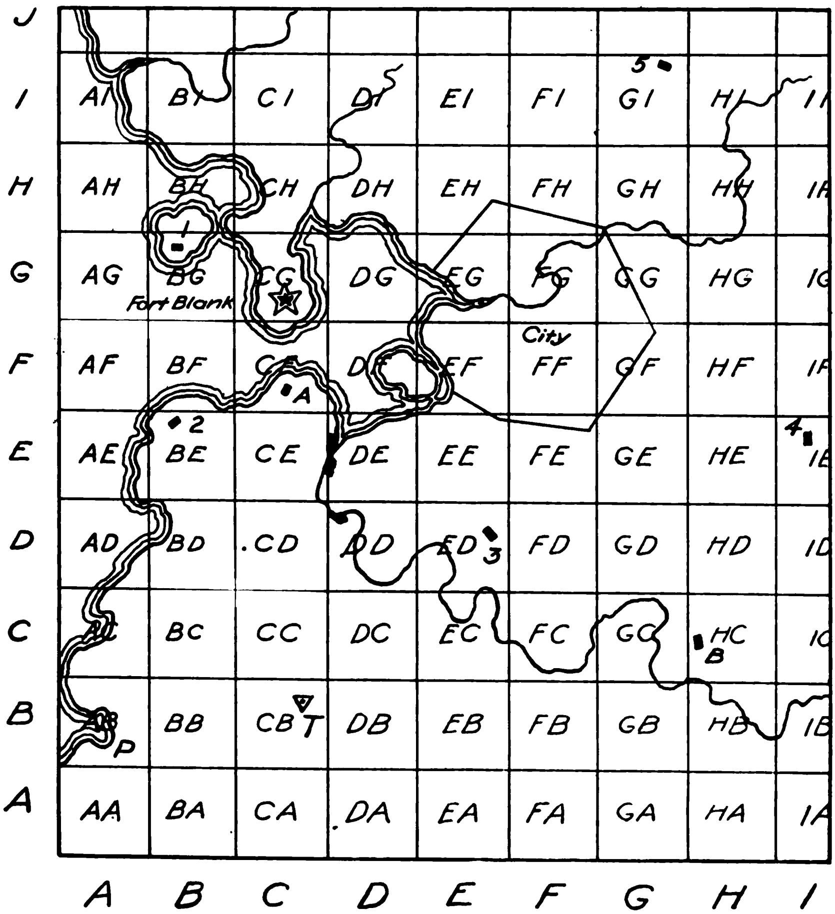
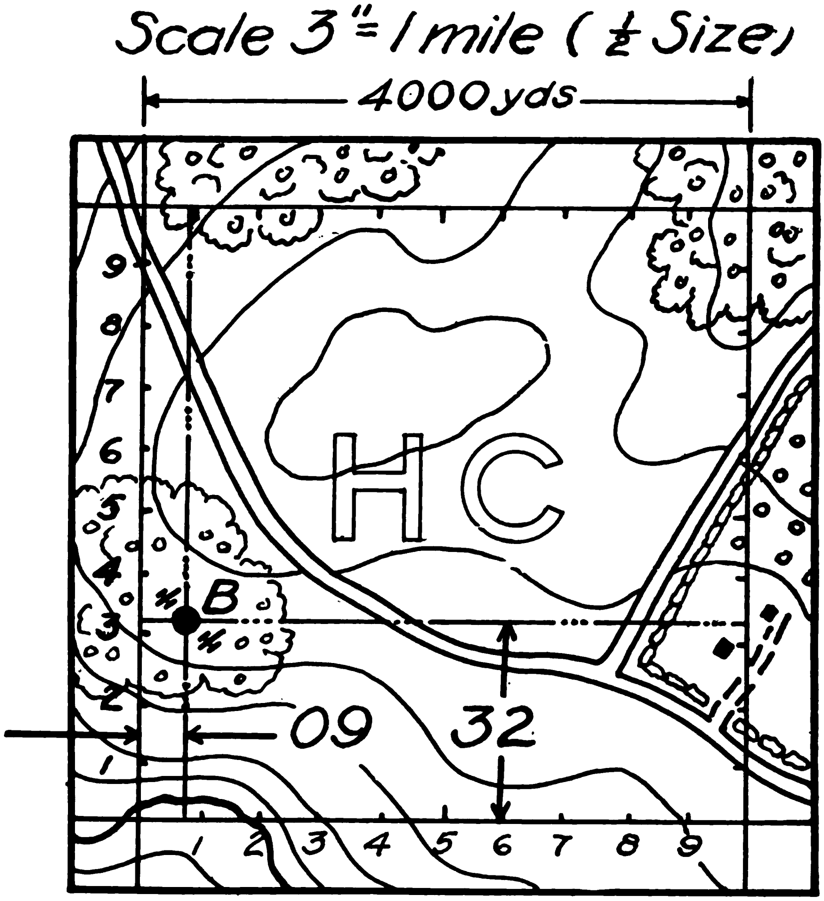


FIG. 4.

1743

plot a target within 1/10 of an inch of its exact location on the map. This would cause an error of only 58.7 yards, which is within the area of burst of a large shrapnel. In country lacking in topographical detail such as woods, salt water flats, swamps, etc., concrete posts or wooden piles could be placed at intervals, numbered and carefully located with the corresponding numbers on the map. Such a sys-

tem of points would undoubtedly prove of great assistance to scouts when locating targets on maps in thick or open country.



Position Battery "B" on Map
HC-09-32

FIG. 5. 1744

The second requisite of this system is that scouts should be trained in locating targets on the map, and in sending back the necessary location data to the battery commander. From each company certain men, naturally fitted for this work, should be trained in reading the map; and be required

to be familiar with the area within range of their battery. These scouts should also be trained in plotting targets on the map, and in sending back the location data of the target by signal, telephone, telegraph, or any other practical means at hand. As soon as the firing has commenced, these scouts should be able to control the fire and bring the center of bursts on the target.

The following method of locating the target on the map could be used. The map of the area to be defended is divided into a system of squares, say 4000 yards on a side. These squares are lettered alphabetically both horizontally and vertically as shown in Fig. 4. Using a system of 4000-yard squares, an area of approximately 60 miles on a side can be covered in this way.

The location of emplacement B on the map would then be by this system in square HC. Its exact position in square HC can be accurately located in a similar manner. The edges of each square are divided into ten parts, and each square has its designation letters printed in the center of it, as HC in Fig. 5. The exact position of a point in any square is then given by its coordinates in that square; thus the position of emplacement B in square HC would be 09-32, the first two digits representing the abscissa and the last two the ordinate. (See Fig. 5.) The location of emplacement B on the map would then be represented by the expression HC-09-32. Similarly, any other point can be accurately located on the map by this system.

To show how the map can be used in land defense for obtaining firing data and for controlling the fire of the batteries previously described, we will assume the following hypothetical problem. The fire control system, when using these same howitzers in sea defense against hostile ships, would be similar to that now used with our present type of seacoast mortar, and needs no discussion here.

EXAMPLE 1. (SEE FIGS. 3 AND 4)

A hostile force has been landed from transports at P and is advancing to attack the city and the fortifications at Fort Blank from in rear. The hostile fleet having located the battery at 2, it has been forced to retire and take up another position in a new emplacement at A, protected by the seacoast guns and mortars mounted at Fort Blank. Col. "A," in command of the coast defenses at Fort Blank, orders Lieut.

"B" to make a flight in a hydro-aeroplane for the purpose of locating the position of the hostile heavy artillery.

Use of the Map

Lieut. "B" being familiar with the terrain locates the hostile heavy artillery near the junction of two roads in square CB. He carefully plots the position at T on his map and reads its location data as CB-75-84, by means of the system previously described. These data he immediately transmits to Col. "A."

Col. "A" assigns this target to Battery 3 and Battery B (which has been moved from its first position at point 4 to B, so as to meet the hostile attack). The battery commanders locate T on their maps by means of these data (CB-75-84) and then read their firing data directly from their maps. Thus the range and azimuth of T from Battery B and Battery 3 are as follows:

Battery B..Range 17,500 yds...Azimuth 85.50°
Battery 3..Range 12,200 yds...Azimuth 52.25°

Lieut. "B" observes the results of the ranging shots from his hydro-aeroplane and sends back the necessary corrections to the battery commanders at B and 3. Thus if the first shot from Battery B was 200 yards short and 80 yards left he sends back the following correction (S-20-R-8). In this way he controls the fire of these batteries and brings the center of burst on the target.

System as Applied to Offensive Operations with Mobile Troops

In large operations with mobile troops it would, of course, be impossible to prepare emplacements and maps in advance. Such maps as could be obtained in the field could be used. Fairly accurate maps are now available of all sections of the United States in which military operations would probably take [illegible] such as the Geodetic Survey Maps, Progressive Mil[illegible] United States, etc., etc. There would be no [illegible]linary circumstances about constructing t[illegible] the howitzers. As soon as the position [illegible] the concrete for the emplacement [illegible]witzers brought up and quickly [illegible] use of a battery under these [illegible] following hypothetical problem.

Fig. 6 represents a portion of a battle line. Our forces are to the south of Black River and the hostile forces are on the north side. Capt. "A," the battery commander, selects the position for his battery at G. While the battery is being mounted he takes a copy of the map of this section of the battle field and divides it into squares 2000 yards on a side

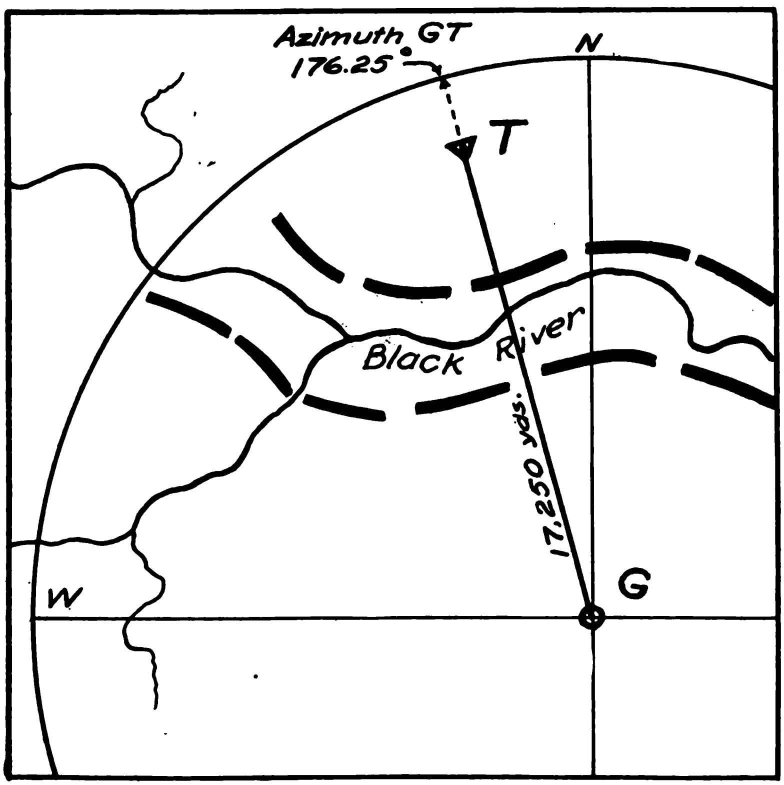


FIG. 6. 1745

in a manner similar to that shown in Fig. 4. He locates the position of G on this map and draws on the map an azimuth circle about G as a center. (See Fig. 6.) He gives a copy of this map to Lieut. "B" and orders him to make a flight in an aeroplane for the purpose of locating the position of the hostile heavy artillery to the north of Black River.

Lieut. "B" discovers the position of the hostile artillery and carefully plots it at T on his map. By means of the Square System he reads the location data of T and immediately sends it to Capt. "A," who plots T on his own map by

this means. Capt. "A" then reads the firing data from his map as shown in Fig. 6 and fires a ranging shot from the battery at G. Lieut. "B" observes the burst of this shot from his aeroplane and signals the necessary corrections to Capt. "A." The fire of the battery is controlled in this way.

Conclusions

The results of the German bombardment and destruction of the short ranged guns mounted in the forts at Liège and Namur have demonstrated the uselessness of depending altogether on stationary unconcealed forts and heavy batteries, unless they have a complement of heavy mobile artillery to act in conjunction with them. It has also been conclusively shown by the unsuccessful attack of the allies fleet at the Dardanelles that it is practically impossible for ships to destroy land fortifications alone and the only chance of such an attack being a success is when the fortifications are attacked from land and sea at the same time. We must, therefore, prepare our seacoast defenses to be able to meet an attack from the rear as well as from the sea. It is, therefore, evident that our seacoast defenses should be augmented by the addition of heavy mobile guns, or howitzers, which can be used not only to keep the hostile ships out of range of our permanent seacoast fortifications but also to defend our seacoast cities and forts from a land attack in the rear.

A suitable mobile heavy howitzer, similar to the large mobile howitzers used so effectively by the Germans and Austrians in the present European war, should be designed by the Ordnance Department and issued to Coast Artillery troops to be used as previously described in this article. A shrapnel should also be designed for the use of these howitzers against animate targets. A system should be devised whereby reserve batteries of these howitzers could be held at central points ready for immediate service. With such a system the maximum results would be obtained with a relatively small number of batteries and small expense for maintenance.

Coast Artillery troops are particularly suited for service with these heavy howitzers, as these batteries will by necessity become a part of our future seacoast defenses. Moreover, both officers and enlisted men are familiar with the technical problems connected with the service of heavy ordnance and will require no additional training. The Enlisted Specialists of the Coast Artillery, Engineers, Firemen, Electrician Ser-

geants, Casemate Electricians, etc., have a technical knowledge of the operation of the gas engine, derived not only from their course of study at the school for Enlisted Specialists at Fort Monroe, Va., but also from their daily duty in operating the many gas engines installed in the power and searchlight plants in our present seacoast defenses. These men would prove invaluable in solving the transportation problems that would be encountered in moving heavy mobile artillery with motor trucks or gasoline tractors over ordinary roads.

The fire control system for these howitzers would be similar to that used with our present seacoast armament. When used against hostile ships, their fire can be controlled by the same system that is used at present with our seacoast mortars. When using these same howitzers to defend against a land attack, their fire, as well as the fire of the permanent seacoast armament, can be controlled by the same map by the system perviously described. Therefore, under this system, Coast Artillery troops will require no additional training in handling heavy mobile artillery and no additional expense will be incurred by the government in providing special troops for this service.

Batteries of heavy mobile artillery manned by Coast Artillery troops can be assigned to the larger units of the mobile army and used as described in Fig. 6. Batteries used in this way would encounter no new problems or require special training. The status of troops of the Coast Artillery Corps when serving in this way with the mobile army, would be the same as that of the troops of the Engineer Corps or Signal Corps under the present system.

Accurate military maps should be prepared in time of peace of all localities in which operations would probably take place in time of war. Positions of emplacements for heavy mobile artillery should be added to the land defense scheme of all important cities or strategic points. Scouts should be trained in locating targets on these maps and in sending back the location data by means of signal, telephone, telegraph, etc.

This system will not only greatly increase the resisting powers of our seacoast defenses against an attack from either land or sea, but it will also provide a highly trained reserve of heavy mobile artillery which can be attached to the larger units of our mobile army and will prove invaluable in case of war.

MINE PREDICTION RULER

BY FIRST LIEUTENANT EDWARD P. NOYES, C. A. C.

In the method now employed, the plotter must measure the travel during the last fifteen seconds, remember it; measure the distance from the last plotted point to the group of mines, remember this also; drop the scale and pick up the slide rule, set it at the first distance and read the number of seconds opposite the second distance, both from memory; and all in a very limited length of time. This process not only involves a great probability of error, but requires the prediction to be made much sooner than it should be in order to designate the proper mine and to determine accurately the time to fire. With the ruler here described, a single operation only is necessary, viz.: place the ruler in the proper position over the track of the target and read off directly the number of the mine and the time to fire in seconds. Nothing is required to be remembered; the operation is simple and rapid, enabling the prediction to be made much later; and a mistake is very improbable, even with an unskilled operator.

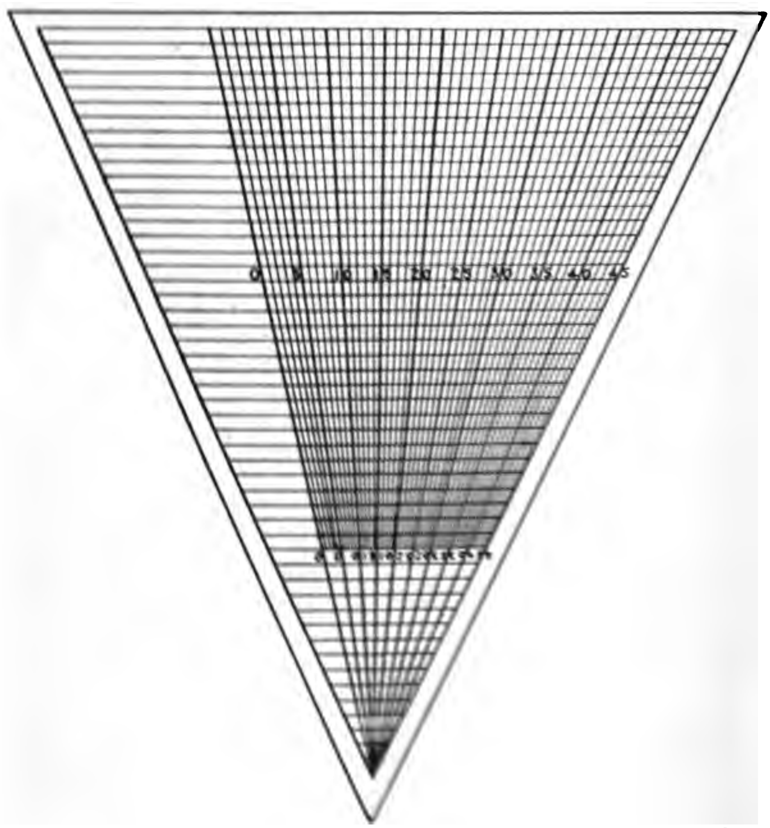
DESCRIPTION

The diagonal lines are so drawn that the part of any of the parallel lines intercepted by the outer diagonal and the one marked 0, is exactly 15 times as long as the part intercepted between any two of the adjacent diagonals numbered from 0 to 60. (See page 16,)

OPERATION

Start the stop watch on the last stroke of the bell at the time when a prediction is to be made. As soon as the point is plotted lay the ruler over the track of the target and make the diagonal marked 0 coincide with the last plotted point and the outer diagonal with the next to the last plotted point, at the same time keeping the parallel lines on the ruler parallel to the course of the target. Read off the Group and Number of the mine nearest the track of the target, prolonged, and

also the number of seconds on the diagonal which passes nearest to this mine. The target should cross the line of mines when this number of seconds has elapsed since the starting of the watch. To avoid parallax, the engraved



MINE PREDICTOR

side of the ruler should always be kept down. If the target is moving from left to right, the apex of the ruler will be towards the plotter; if it is moving from right to left, the apex will be away from the plotter.

NOTES ON GUNNERY

BY FIRST LIEUTENANT GEORGE A. WILDRICK, C. A. C.

DEVIATIONS

The following definitions are taken from *Drill Regulations for Coast Artillery, 1914:*

Deviation.—As used in coast artillery practice, deviations are either the horizontal distances of the points of splash from the center of the target, or the rectilinear coordinates of those distances. Deviations are measured in a plane passing through the waterline of the target and parallel to the horizontal plane through the muzzle of the piece in the firing position.

Absolute Deviation.—The shortest distance between the center of the target and the point of splash.

Lateral Deviation.—The distance between the plane of direction and the plane of splash measured (right or left) from the center of the target and perpendicular to the plane of direction.

Longitudinal Deviation.—The perpendicular distance (over or short) of the point of splash from the vertical plane passing through the center of the target and perpendicular to the plane of direction.

Mean Lateral Deviation.—The algebraic mean of the lateral deviations of a series of shots.

Mean Longitudinal Deviation.—The algegraic mean of the longitudinal deviations of a series of shots.

Range Deviation.—The difference between the range to the target (at the instant the projectile strikes) and the range to the point of splash. The range deviation is equal to the longitudinal deviation when the lateral deviation is zero.

Fig. 1 illustrates these definitions.

XY is a horizontal plane. (Strictly speaking it is parallel to the initial plane.)

$X'Y'$ is a vertical target perpendicular to the plane of direction.

A is the center of the horizontal target.

A' is the center of the vertical target.

DI is the lateral deviation on the horizontal target.

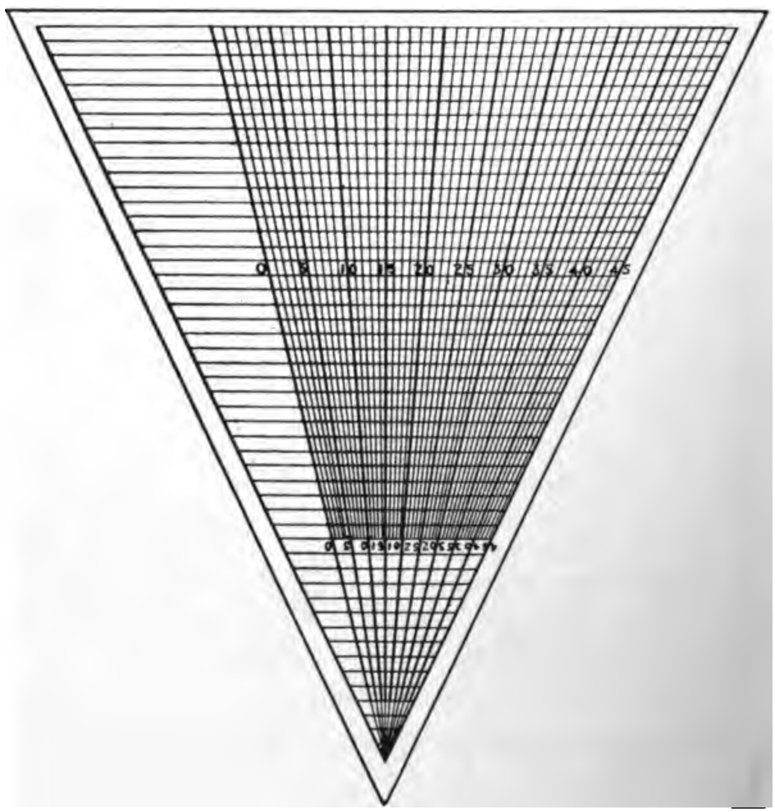
$D'I'$ is the lateral deviation on the vertical target.

AD is the longitudinal deviation.

$A'D'$ is the vertical deviation on the vertical target.

AI and $A'I'$ are the absolute deviations.

also the number of seconds on the diagonal which passes nearest to this mine. The target should cross the line of mines when this number of seconds has elapsed since the starting of the watch. To avoid parallax, the engraved



MINE PREDICTOR 1746

side of the ruler should always be kept down. If the is moving from left to right, the apex of the ruler towards the plotter; if it is moving from right to ' apex will be away from the plotter.

the target, is the alge-
of impact.
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e center of impact

Lateral Deviation yds.	
R	L
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----	8.38
----	18.00
2.74	-----
2.74	36.00

$$\frac{-36+2.74}{4} = -8.3.$$

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3) assume the point O as
n for illustration as the
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have, for a range of 7940,

$10'.4$

$+ h\left(\frac{1146}{R}\right) = 2' + 28'.9 = 30'.9$

$= 6° 41'.3$

$$AI=\sqrt{(AD)^2+(DI)^2} \qquad A'I'=\sqrt{(A'D')^2+(D'I')^2}$$

The following is quoted from *Drill Regulations for Coast Artillery, 1905, Gunnery:*

Center of Impact

14. The center of impact of a group of shots is a point so situated that the algebraic mean of the longitudinal distances measured from this point and also the lateral distances measured from this point to each point

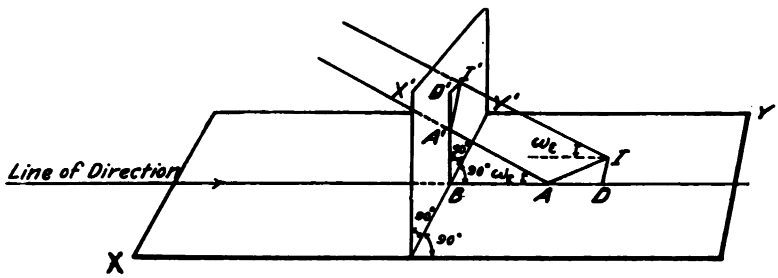


Fig. 1. 1747

of impact will be equal to zero. This idea can probably be best explained as follows: Draw a straight line from the muzzle of the gun to each of the points of impact. These lines we will call the *lines of fire* of the several shots; the lengths of these lines will be the ranges of the several shots. Now draw *a mean line of fire* such that the sum of the distances from it of all the points of impact to its right will be exactly equal to the sum of the distances from it of all of the points of impact to its left. This

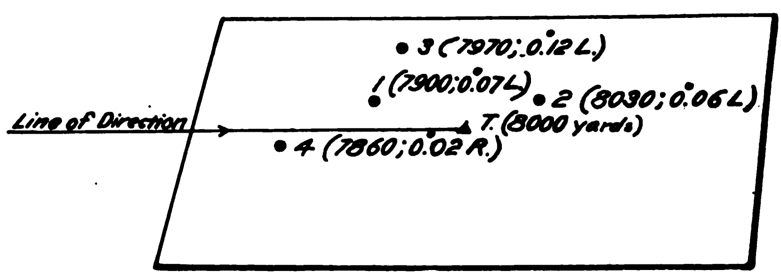


Fig. 2. 1748

mean line of fire will pass through the center of impact. Now lay off on this line from the muzzle of the gun a distance equal to the average of the lengths of the several lines of fire; that is, equal to the average range of the shots and mark this point. This point will be the center of impact of the group of shots, which, therefore, determines the point of impact of the mean trajectory of the shots fired.

The center of impact of a group of shots is located by the longitudinal and lateral deviations from the center of the target.

The *longitudinal deviation of the center of impact* from the target, is the algebraic mean of the longitudinal deviations of all the points of impact.

The *lateral deviation of the center of impact* from the target, is the algebraic mean of the lateral deviations of all the points of impact.

The *absolute deviation of the center of impact* from the target is the square root of the sum of the squares of the longitudinal and lateral deviations [of the center of impact].

PROBLEM 1

See Fig. 2. Assume T as the center of the horizontal target at 8000 yards. The position of the point of impact of each of four shots is as shown. Where is the center of impact with reference to the center of the target?

Shot No.	Range	D°		Lateral Deviation yds.	
		R	L	R	L
1	7900	---	.07	----	9.62
2	8030	---	.06	----	8.38
3	7970	---	.13	----	18.00
4	7860	.02	---	2.74	-----
Sums	31760			2.74	36.00

Mean Range $= 31760 \div 4 = 7940$. Mean Lat. Dev. $= \dfrac{-36+2.74}{4} = -8.3$.

Note: Lateral Deviation, yds., $= \dfrac{D^\circ}{^\circ.05} \times R \times .00087 = D^\circ \times R \times .0174$.

The longitudinal deviation of the center of impact is therefore $7940 - 8000 = -60$ yards.

The lateral deviations of the center of impact is -8.3 yards.

On the vertical target (see Fig. 3) assume the point O as the point of reference. It is taken for illustration as the intersection of the plane of direction, the horizontal at the surface of the water (XY), and the vertical target ($X'Y'$) at right angles to the plane of direction.

Assume: a 12-inch gun and long pointed projectiles. Height of site, 200 feet.

From the range table we have, for a range of 7940,

$$\omega = 6^\circ\ 2' + 12' \times \frac{140}{200} = 6^\circ\ 10'.4$$

$$\epsilon = \Delta\varphi_k + \Delta\varphi_h = \frac{R}{4000} + h\left(\frac{1146}{R}\right) = 2' + 28'.9 = 30'.9$$

$$\omega_\epsilon = 6^\circ\ 10'.4 + 30'.9 = 6^\circ\ 41'.3$$

Referring to the range table we see that the slope of fall corresponding to 6° 40′ is 1 on 8.55; and we see that the slope of fall for our value of 6° 41′.3 is 1 on 8.53 to sufficient accuracy. Where the center of impact is so close to the target we reduce the longitudinal deviation to the vertical as follows:

$$-60\times\frac{1}{8.53}=-7 \text{ yards}=-21 \text{ feet}$$

The lateral deviation on the vertical target is

$$\frac{8000}{7940}\times -8.3=-8.36 \text{ yards}=-25 \text{ feet}$$

I represents the center of impact on the horizontal; *I′*, the center of impact on the vertical.

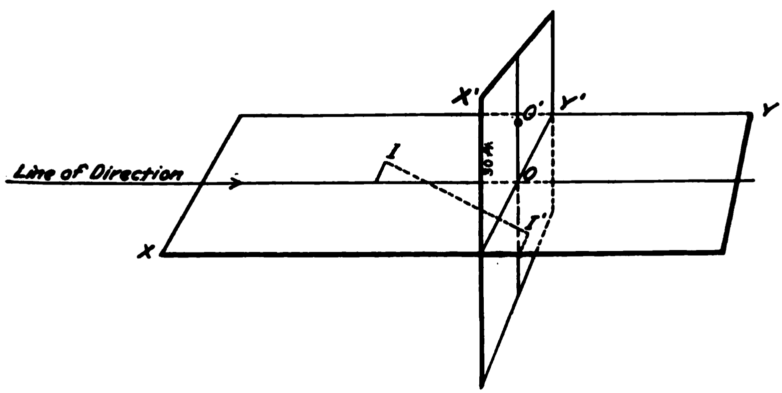


FIG. 3. 1749

Assuming the vertical target $X'Y'$ to be 30 feet high, and the point of aim, O', to be the center of the vertical target, then the coordinates of the center of impact on the vertical target becomes $-(15+21)=-36$ feet and -25 feet.

The absolute deviation of the center of impact measured from O is: in the horizontal plane $=\sqrt{(60)^2+(8.3)^2}\doteq 60.6$ yds; in the vertical plane at the target $=\sqrt{(21)^2+(25)^2}=32.6$ ft.

The mean absolute deviation of the center of impact measured from O' is: in the vertical plane at the target $=\sqrt{(36)^2+(25)^2}=43.8$ ft.

ERRORS

The divergences of the points of impact, if the gun is properly laid by the best information at hand, are due to variations in the action of the gun, carriage, powder, pro-

jectile, and meteorological conditions along the range. These divergences when measured *from the center of impact* are called *errors.*

If we draw a line in the horizontal plane through the center of impact and parallel to the line of direction, we may determine the *longitudinal error*, the *lateral error*, and compute the *absolute error* of each shot in a manner similar to that by which we determined the corresponding deviations of each shot from the center of the target. *The mean absolute error is the mean of the absolute errors of the individual points of impact*, and cannot be computed correctly, in the general case, from the mean lateral and mean longitudinal errors.

The errors of a point of impact are the algebraic differences between its longitudinal and lateral deviations, and the longitudinal and lateral deviations respectively of the center of impact.

Problem 2

From the data in Problem 1 compute the longitudinal, lateral, and absolute errors of each shot in the horizontal plane of the target.

The center of impact was found to have a longitudinal deviation of -60 yards and a lateral deviation of -8.3 yards from O, Fig. 3.

Shot No.	Deviation				Dev. of C. I.		Errors		
	Longitudinal		Lateral		Long.	Lat.	Long.	Lat.	Absolute
	+	−	+	−	−	−			
1	--	100	----	9.62	60	8.3	40	1.32	40.0
2	30	---	----	8.38	60	8.3	90	0.08	90.0
3	--	30	----	18.00	60	8.3	30	9.70	31.5
4	--	140	2.74	-----	60	8.3	80	11.04	80.8
					Sum----		240	22.1	242.3
					Mean---		60	5.5	60.6

Note: Had we computed the mean absolute error from the mean longitudinal and mean lateral errors we would have had: M.A.E. $= \sqrt{(60)^2+(5.5)^2} = 61.3$ yards. The difference may be of appreciable value.

Accuracy of Fire and Practice

12. A clear and well defined distinction must be made between *accuracy of fire* of a gun and *accuracy of practice* with the same gun. The difference between these terms can best be shown by an example.

An officer is ordered to fire five shots at a fixed target, range 9000 yards. The shots all fall within a rectangle 20 yards long and 4 yards

wide, but the average distance of these five shots from the target is 300 yards short and 10 yards right. The accuracy of fire was excellent; but the accuracy of practice, poor.

Generally speaking, what is meant by the *center of impact* is the *center* of the *points of impact* of a group of shots.

Accuracy of fire is measured by the mean distance of the points of impact of all the shots in a group from the center of impact.

Accuracy of practice is measured by the distance of the center of impact from the center of the target.

Accuracy of fire depends upon:

The accuracy of the gun.

The uniform movement of the carriage during each recoil while each shot is in the bore.

The uniformity of the ammunition (and its behavior).

[The uniformity of meteorological conditions along the trajectory, etc.]

[Accurate laying or pointing.]

Measures of Accuracy

17. The absolute deviation of the center of impact from the target, is the measure of the accuracy of practice. The longitudinal deviation of the center of impact from the target, is the measure of the accuracy of the range practice and the lateral deviation of the center of impact is the measure of accuracy of the practice considered only with reference to the lateral deviation.

The mean of the absolute errors measured from the center of impact, is the measure of the accuracy of fire. If the range accuracy is desired it is determined by the mean of the longitudinal errors. The accuracy considered laterally is determined by the mean of the lateral errors.

The mean deviations from the target are used only for the purpose of comparing groups of shots on a horizontal or in a vertical plane.

The most satisfactory figure of merit for comparing the target practice of different batteries is the mean absolute deviation from the target. When however it is desired to study the practice of a single battery it is essential that the accuracy of practice should be differentiated from the accuracy of fire; to do this the center of impact must be located and the mean of the absolute errors must be determined.

Probable Error

18. It is exceedingly important that a battery commander should know what is the best that the gun will do under the most favorable conditions, in order that he may intelligently correct for the observed errors in practice and may be able to compare the accuracy of fire that he has obtained with the maximum accuracy of fire obtainable from the gun.

If a gun were fired a great number of times with the same laying and with uniform atmospheric conditions, that is under the most favorable conditions for accuracy of fire, the projectiles would not all strike the same point but would be scattered over a certain area and would be more or less symmetrically disposed about the center of impact of the group. Within a certain area immediately about the center of impact the shots would be somewhat densely grouped, and the density of grouping would decrease as the distance from the center of impact increased.

Fig. [4] gives an exaggerated idea of a sheaf of trajectories, all fired under the most favorable circumstances with the same laying.

The central white line represents the *mean trajectory* which passes through the center of impact. The dark sheaf is that in which 50% of the trajectories lie. The shaded sheaf is that in which 25% of the trajectories lie and the outer portion of the sheaf contains the remainder.

A *zone* is a space bounded by two parallel straight lines of indefinite length. By the "theory of probabilities" the dimension of the zone in which 50% of the points of impact will probably lie can be computed from the result obtained by firing a sufficient number of shots and determining the mean of the errors measured from the center of impact.

The accuracy of a gun is indicated by the manner in which a number of shots with exactly the same laying are grouped, even though they may fall some distance from the target.

The closer the grouping about the center of impact the greater the accuracy of the gun. The accuracy of the gun or in fact the accuracy of any firing is measured by the mean longitudinal and lateral errors from the center of impact; the less the error the greater the accuracy. After

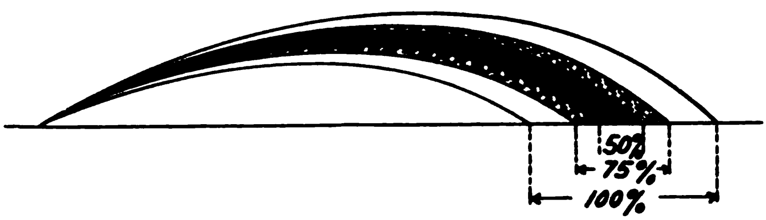


FIG. 4. 1750

having obtained the mean error from the center of impact, measured in a given direction, the probability of a future shot exceeding any particular error in the same direction, can be computed by the theory of probabilities. There is one particular error in any direction which it is an even chance will not be exceeded by any shot. This error is called the *probable error*, in that direction.

The probable error has nothing to do with the probability of hitting the target, but refers entirely to the divergence of a shot from the center of impact of a group of shots which have been fired under the same conditions.

It is important that the term *probable error* should be clearly understood, as the ordinary use of the words convey a different idea from that intended. When it is said that the "probable lateral error" of a gun is 10 yards, it is not meant that the lateral divergence from the center of impact will probably be 10 yds., but that if a great number of shots were fired under the same conditions and with the same laying, that 50% of them would have a divergence of less than 10 yds. from the center of impact, the remaining 50% having a greater divergence. In considering what will happen when firing a single shot from this gun, all that can be predicted is that it is an *even chance* that its lateral error will be less than 10 yards.

The *probable error* of a gun, in any direction, is a distance measured in that direction from the center of impact, of such length that it is an

even chance that it will not be exceeded by any single shot, and for which it can be predicted that in the *long run* 50% of all the shots fired will have a less error.

By the theory of probabilities it can be mathematically demonstrated that the probable error in any direction is equal to the mean error in that direction multiplied by 0.845.

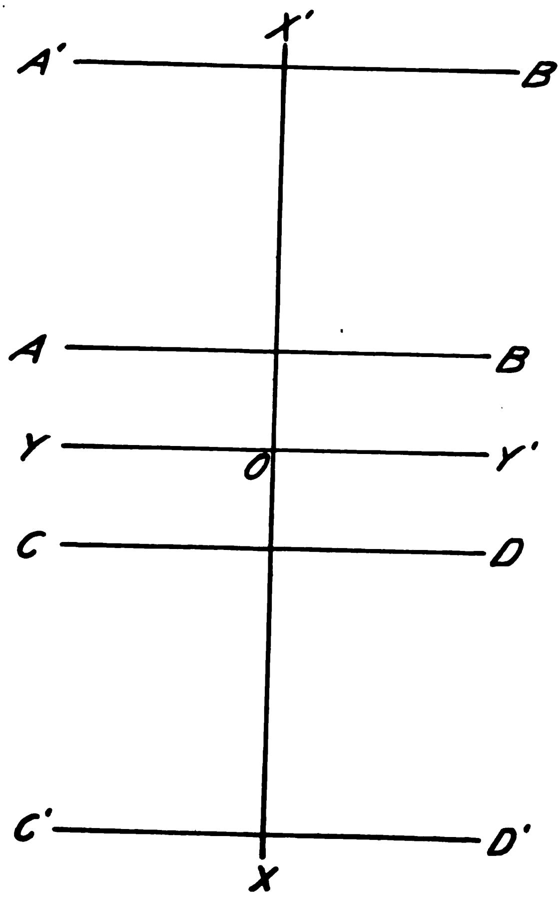


FIG. 5.

Thus if it is determined by actual firing under certain conditions and the same laying that the mean longitudinal error of a number of shots is 40 yds. then the *probable longitudinal error* will be 40 × 0.845 = 33.8 yds.; that is 50% of all the shots fired will not have a greater longitudinal error than 33.8 yds. and it is an even chance that the longitudinal error of any particular shot will not exceed 33.8 yds.

In the same way if the mean lateral error of a group of shots is 6 yds., the "*probable lateral error*" will be 6 × 0.845 = 5.07 yds. It is an even chance that the lateral error of any particular shot will not exceed 5.07

yds., and it can be predicted as probable that 50% of all shots which have been fired will have a lateral error of less than 5.07 yds.

In Fig. [5] let O be the center of impact. Draw through O the line XX' parallel to the line of direction and YY' perpendicular to the line of direction. Now draw the line AB parallel to YY' beyond O and distant therefrom 0.845 times the mean of the longitudinal errors as determined by firing a number of shots. Then 50% of all the points of impact beyond

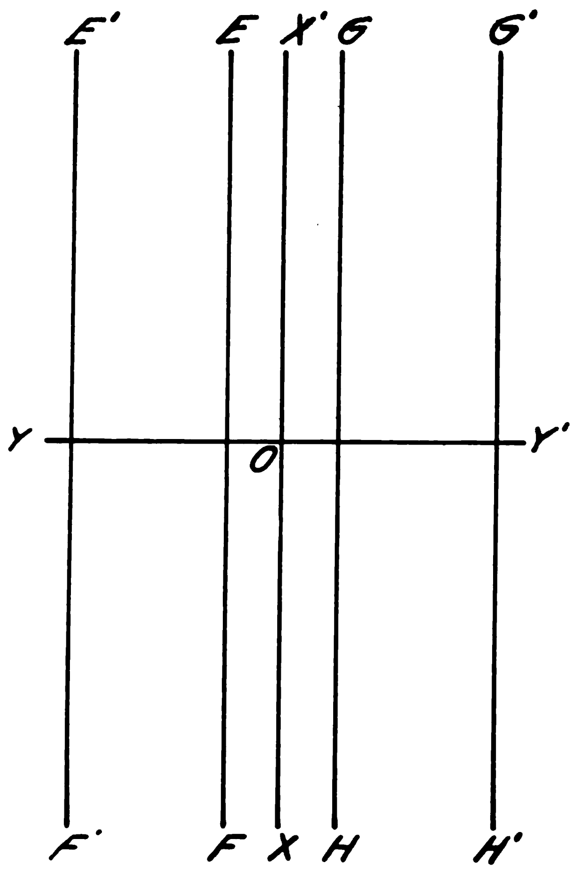


FIG. 6. 1752

YY' will be found in the zone AB—YY'. In the same manner draw CD parallel to YY' distant therefrom 0.845 times the mean longitudinal error. Then 50% of all of the points of impact short of YY' will fall in the zone YY'—CD.

The zone AB—CD has a width equal to 1.69 times the mean of the longitudinal errors and will manifestly contain 50% of all the points of impact. This zone has been determined from the longitudinal errors and is entirely independent of the lateral errors, it is therefore called the 50% *longitudinal zone.*

It can also be mathematically demonstrated that if two lines $A'B'$ and $C'D'$ be drawn parallel to YY' so that the width of the zone $A'B'—C'D'$ shall be four times the width of the 50% zone that they will determine the boundaries of the maximum longitudinal zone.

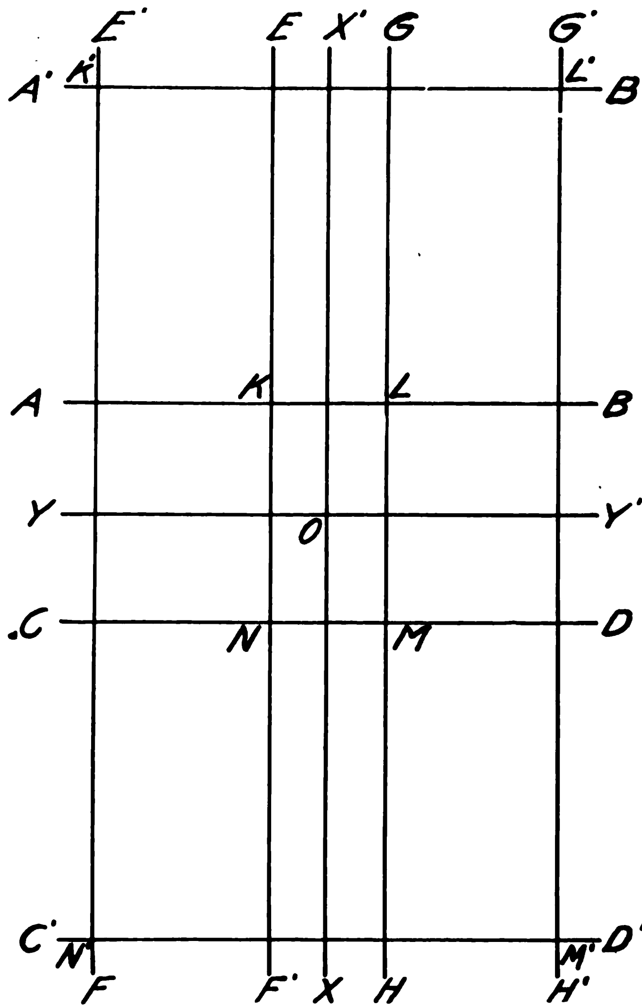


FIG. 7. 1753

The maximum longitudinal zone is the zone which will contain practically all the shots fired. It is not absolutely certain that all the shots will fall in this zone as sporadic shots may fall anywhere, but it can be demonstrated that over 99% of the shots will fall in this zone.

By the same process the 50% lateral zone and the maximum lateral zone can be determined from the mean of the lateral errors.

In Fig. [6] *EF—GH* is the 50% *lateral zone*, its width being 1.69 times

the mean of the lateral errors, the lines being drawn parallel to XX'. $E'F'$—$G'H'$ is the *maximum lateral zone*, its width being four times that of the 50% lateral zone.

If, as in Fig. [7], the two zones are superposed one on the other two rectangles will be formed. The smaller one $KLMN$ will contain 50% of 50% = 25% of all the points of impact and is called the 25% *rectangle*.

The larger rectangle $K'L'M'N'$ will contain all or very nearly all the points of impact and is called the *total rectangle*.

The width of a 50% zone is twice the probable error in the direction considered. If these rectangles have been determined from a gun fired under the most favorable conditions with exactly the same laying, they will represent the best that the gun can do.

To keep all of the shots within the total rectangle is the best that can be expected from the gun, and indicates perfect accuracy of laying.

Probability of Hitting

The following table gives the values of Z/Z_1, with the percentage of hits corresponding thereto. The table is to be found in the following works by Major Alston Hamilton:— *Ballistics, Part I* and "Notes on Ballistics," Journal of the United States Artillery, November-December, 1909.

Table E

Values of Z/Z_1

%	Factor Z/Z_1	%	Factor Z/Z_1	%	Factor Z/Z_1	%	Factor Z/Z_1	%	Factor Z/Z_1
1	0.02	21	0.40	41	0.80	61	1.27	81	1.94
2	0.04	22	0.41	42	0.82	62	1.30	82	1.98
3	0.06	23	0.43	43	0.84	63	1.33	83	2.03
4	0.07	24	0.45	44	0.86	64	1.36	84	2.08
5	0.09	25	0.47	45	0.89	65	1.39	85	2.13
6	0.11	26	0.49	46	0.91	66	1.42	86	2.18
7	0.13	27	0.51	47	0.93	67	1.45	87	2.24
8	0.15	28	0.53	48	0.95	68	1.48	88	2.30
9	0.17	29	0.55	49	0.98	69	1.51	89	2.37
10	0.18	30	0.57	50	1.00	70	1.54	90	2.44
11	0.20	31	0.59	51	1.02	71	1.57	91	2.52
12	0.22	32	0.61	52	1.04	72	1.60	92	2.60
13	0.24	33	0.63	53	1.07	73	1.64	93	2.69
14	0.26	34	0.65	54	1.09	74	1.67	94	2.78
15	0.28	35	0.67	55	1.12	75	1.71	95	2.91
16	0.30	36	0.70	56	1.14	76	1.74	96	3.04
17	0.32	37	0.72	57	1.17	77	1.78	97	3.22
18	0.34	38	0.74	58	1.19	78	1.82	98	3.45
19	0.36	39	0.76	59	1.22	79	1.86	99	3.82
20	0.38	40	0.78	60	1.25	80	1.90	100	

(A factor 5, or even 4, and of course one greater than either of these stands for practically 100%.)

If the width of either the horizontal or vertical target is represented by Z; and the width of the horizontal or vertical 50% zones, respectively, by Z_1; then opposite the value of the ratio Z/Z_1 can be found the probability of hitting to be expected *in the long run* if the center of impact is on the center of the target presented.

Problem 3

The mean horizontal error of a gun at a given range is ±80 yards. What is the probability of hitting a horizontal target having a longitudinal dimension of 120 yards, provided the C.I. is on the center of the target? $Z=120$ yds.

The width of the 50% zone is $80 \times 1.69 = 135.2$ yds. $= Z_1$

$$\frac{Z}{Z_1} = \frac{120}{135.2} = .888$$

In Table E the probability of hitting is about 45%, corresponding to a value of $Z/Z_1 = .89$.

Problem 4

The mean horizontal error of a gun at a given range is ±80 yards. What is the probability of hitting a horizontal target having a longitudinal dimension of 120 yards, provided the C.I. is on a point 40 yards short of (or beyond) the center of the target?

A convenient path to a solution is to consider the target to be resolved into two hypothetical targets each of which is symmetrically disposed about the C.I.; then to compute the probability for each hypothetical target; then to take ½ the sum of these (i.e., the mean) as the probability of hitting the actual target.

Thus the longitudinal dimension of target A is

$$\left(\frac{120}{2} - 40\right) 2 = 40$$

The width of the 50% zone is $= 1.69 \times 80 = 135.2$.

$\frac{Z}{Z_1} = \frac{40}{135.2} = .296$, and the corresponding probability is 16%.

The longitudinal dimension of target B is

$$\left(\frac{120}{2} + 40\right) 2 = 200$$

$\frac{Z}{Z_1} = \frac{200}{135.2} = 1.48$, for which the corresponding probability is 68%.

Therefore the probability of hitting the actual target is

$$\frac{16\% + 68\%}{2} = 42\%$$

For a gun having the mean error as stated above, and for the given range, we may expect to lose three hits out of every hundred shots due to having the center of impact 40 yards short of (or beyond) the center of the target. The C.I. referred to implies a C.I. determined by an appreciable number of shots. The C.I. determined by 3 or 4 shots may be materially different from the C.I. of the group. Therefore where we make an adjustment of impact on only 3 or 4 shots (as is done by expressing the deviation of the center of impact in terms of velocity) we stand a good chance of throwing our true C.I. materially off the center of the target, or point laid for if this does not coincide with the actual towed target or point observed upon.

Problem 5 (a)

In order to secure a relatively large number of shots upon which to base a study, we can conveniently refer to pages 114, *Technical Notes and Extracts from Reports of Coast Artillery Target Practice for 1911*, and to pages 30 and 32 of the similar publication for the target year 1912. The selection was made at random. We can study the combination of the 12-inch gun, Model 1895; capped projectiles; carriage, D. C.; powder, Int. No. 29, 1910; and the meteorological conditions existing at the times of the several firings.

First we will assume that the deviations would have been the same had the trial shots been fired at an uncorrected range of 8000 yards.

Second, we will determine the differences in range corrections due only to differences in assumed velocity. Third, we will adjust all range deviations to what they would have been if the assumed velocities had all been 2218.

For this work a Velocity Graphic chart was used. All the batteries have heights of sites falling within the limits for which the chart used was constructed. Due to the low sites, and the long range, it was felt that the error in the range correction charts used at the time could be ignored for purposes of the illustration, and without appreciable error.

$\Delta R(V)$ is the range correction due to the velocity assumed. It is assumed that the corrections for atmosphere, wind, and

I	II	III		IV	V	VI	VII	VIII		IX		X	
Group No.	Shot No.	Point of Impact		Actual Range	M.V. Assumed	ΔR (V)	ΔR' (V)	Points of impact adjusted on common V		Center of Impact		Errors	
		+	−					+	−	+	−	+	−
1	1		177	8390	2218	+190	0		177		190	13	
	2		248	8390	2218	+190	0		248		190		58
	3		237	8390	2218	+190	0		237		190		47
	4		143	8390	2218	+190	0		143		190	47	
2	5		228	8190	2214	+200	+10		238		190		48
	6		120	8190	2214	+200	+10		130		190	60	
	7		94	8190	2214	+200	+10		104		190	86	
	8		285	8200	2214	+190	0		285		190		95
3	9	202		8020	2170	+440	+250		48		190	142	
	10	214		8020	2170	+440	+250		36		190	154	
	11	17		8020	2170	+440	+250		233		190		43
	12	100		8020	2170	+440	+250		150		190	40	
4	13	11		8070	2198	+290	+100		89		190	101	
	14	0	0	8070	2198	+290	+100		100		190	90	
	15		47	8000	2198	+360	+170		217		190		27
	16		47	8000	2198	+360	+170		217		190		27
5	17		480	8050	2227	+140	−50		430		190		240
	18		214	8050	2200	+280	+90		304		190		114
	19		138	8050	2200	+280	+90		228		190		38
	20		94	8050	2200	+280	+90		184		190	6	
								Sum	−3798	Sums		739	737

Sums 739 + 737: 20)1476

Mean Error 73.8 yards.

C.I. = −3798/20 = −189.9 = −190
Probable Error = .845 × 73.8 = 62.4 yards.
50% Zone = 1.69 × 73.8 = 125 yards.

tide compensated for the range effect to be expected from any variations in these conditions from the normal. Therefore the whole deviation of each shot is attributed to a false assumption of velocity.

$\Delta R'(V)$ is the algebraic difference between the range correction for the assumed velocity and the range correction for 2218 f.s. Thus, for the 3rd group where a muzzle velocity of 2170 was taken, the range correction therefor was +440. And because a greater ranging of the shot was to be expected by an amount $(+440-190=250)$ than where 2218 was assumed, we correct the deviation of each shot by 250. Thus for the 10th shot which actually fell +214, we would have expected it to fall +250, wherefor we call it $(214-250=-36)$, and so adjust it to approximately where it would have fallen had the velocity assumed been 2218 instead of 2170.

It will be observed that these errors and deviations are due not only to variations in velocity, but also to errors in determining and allowing for the true meteorological conditions along the trajectory of each shot, and such errors of the piece as those due to non-uniform jump, etc. The 20 shots represent fairly the practical gunnery problem for this combination of ordnance matériel under average conditions.

The trial shots alone are considered because the laying is deliberate and the accuracy of laying is to be relied upon.

Conscientious analyses of practices in the future will segregate the errors of personnel from armament errors, the latter including errors of correction devices as well as those of the pieces themselves. The publication of these two errors for each shot would add greatly to the number of shots from a gun and powder study.

Assuming the center of impact to be on the center of the 1915 record target, Form 1000, (which would be accomplished by using the mean "velocity" together with the proper tide correction to place the center of impact the proper additional distance beyond the actual towed target), what is the probability of hitting with perfect laying if the height of site is 200 feet and the range to the target is 8000 yards?

We will consider only the *A* section of the target. The horizontal longitudinal dimension of the target is equal to 13 yards multiplied by the tangent of the range table angle of fall corresponding to the corrected range. We will assume zero range correction. Shots falling not more than 10 yards

short are also scored as hits. Our horizontal target is therefore (noting that the depression angle is omitted in the computation of the horizontal target):

$13 \times 7.7 + 10 = 110$ yards.

$\frac{Z}{Z_1} = \frac{110}{125} = .88$ for which the probability is 45%.

In the *long run* we may expect about 45% of hits with perfect laying, provided the center of impact coincides with the center of the target. It does not mean that the battery should make as much as 45%, nor as little as 45%, in a string limited to seven or eight shots. Errors of personnel may compensate for armament errors, thus securing hits where perfect laying would secure misses. Or the center of impact, and the "velocity" determined therefrom, of three trial shots may differ from the true center of impact, or the true mean "velocity"; and the shots in the record string may be laid theoretically in error sufficiently to cause shots having small errors in one direction to be misses, and shots having large errors in the opposite direction to be hits. The true criterion of the training and efficiency of a battery is shown by the analysis of the practice. Small or zero errors of personnel is the best that can be expected of the battery. The element of chance in the number of hits secured is not to be denied.

We have figured out that in the *long run* 45% of hits should be secured with perfect laying and with the true center of impact (as adjusted by the true mean "velocity" determined from previous firings) on the center of the *A* section of the 1915 record target at 8000 yards. Say we had fired the 20 shots in a record string, and assuming the above conditions. How many hits would have been secured?

Each shot may have an error of $\pm\frac{110}{2} = \pm 55$ yards and be a hit. We see that shots No. 1, 3, 4, 5, 11, 12, 15, 16, 19, and 20 have errors less than 55 yards and so these would have been hits, giving 50%.

Perhaps the most interesting question involved is whether it is preferable to base our muzzle velocity for a record string on previous firings as well as present trial shots, *or* to use previous shots merely to get the "velocity" to fire the trial shots with, and then throw away all our previous information in favor of only three.

PROBLEM 5 (b)

Compute the data for, and construct, a curve showing how the probability of hitting will be affected by shifting the center of impact from the center of the *A* section of the 1915 record target at 8000 yards.

Assume the center of impact to be 20 yards over (or short) of the center of the hypothetical target. Then the error may be either $-\left(\frac{110}{2}+20\right)$ or $+\left(\frac{110}{2}-20\right)$ for the projectile to land on the target.

$55+20=75$ yards that the projectile may fall short; that is, have a minus error of 75 yards. The probable error is ± 62.4 yards. Therefore the probability that the error will not exceed -75 yards is,

$\frac{Z}{Z_1}=\frac{75}{62.4}=1.20$ for which the probability is 58%. But since one-half the shots may fall over and one-half may fall short, and we are limited to the latter, the probability that this distance short will not be exceeded is $\frac{58\%}{2}=29\%$.

Similarly the probability that the shot will not exceed $55-20=35$ yards, plus, is

$\frac{Z}{Z_1}=\frac{35}{62.4}=.56$ for which the probability is 29.5%.

Because one-half may fall over, and one-half may fall short, our probability becomes $\frac{29.5}{2}=15\%$.

Then our total probability is $29\%+15\%=44\%$.

When the center of impact is off the target we solve as follows:

Assume the C.I. at 80 yards beyond (or short) of the center of the hypothetical target. In this case only a certain number of the shots falling short (or over) of the center of impact by distances included within the distance from the C.I. to the near edge and from the C.I. to the far edge of the target will hit the target. These limits are $-(80-55)=-25$ to the near edge, and $-(25+110)=-135$ to the far edge.

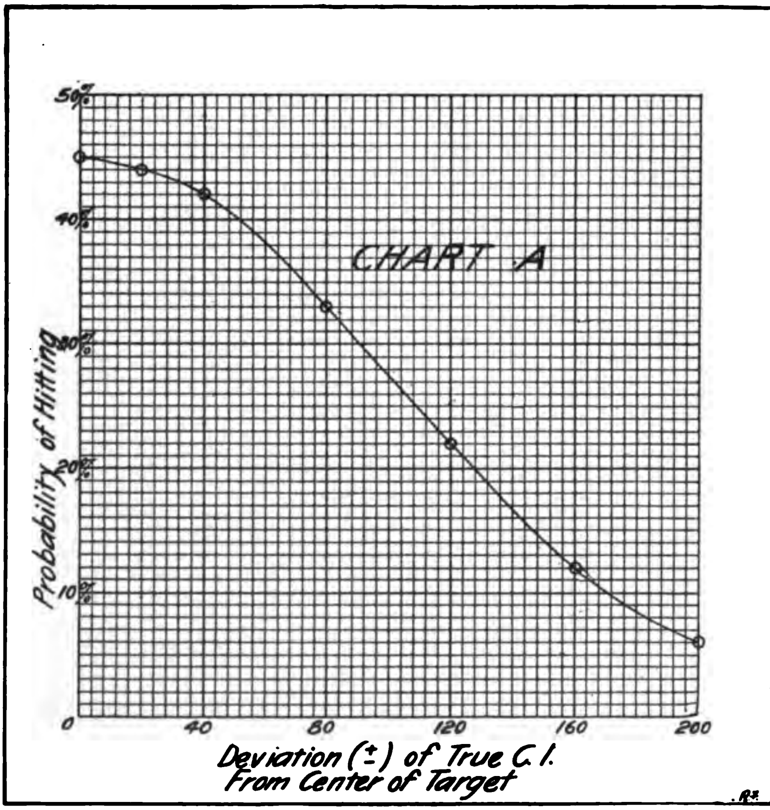
What is the probable number of shots which will have an error not exceeding 25 yards?

$\frac{Z}{Z_1}=\frac{25}{62.4}=.40$ for which the probability is 21%. The probability that the shot will not fall over 25 yards short is

one-half of 21% = 10.5%. Only one-half of the total number of shots can be expected to fall short of the C.I. Therefore we may expect 50% − 10.5% = 39.5% to fall more than 25 yards short.

Similarly, what is the probable number of shots which will each have an error not exceeding 135 yards short?

$$\frac{Z}{Z_1} = \frac{135}{62.4} = 2.16 \text{ for which the probability is } 85.5\%.$$



1754

Since we are limited to the ½ which can be expected to fall short, our probability becomes $\frac{85.5}{2} = 42.8\%$.

Of these 42.8% we previously found that 10.5% would not fall far enough short. Therefore our probability of hitting the target is 42.8% − 10.5% = 32%.

The following table shows the results of the computation.

Deviation of C.I. from Center of Target		Probability of Hitting
+	−	%
0	0	45
20	20	44
40	40	42
80	80	33
120	120	22
160	160	12
200	200	6

For the curve, see Chart A.

PROBLEM 5 (c)

Consider that Chart A is based upon a *priori* information, and that we have this series to fire again. Take 20 slips of paper, give each a serial number to represent a shot, mix them up in a bag. Assume that we have three trial shots. Draw three slips from the bag. The writer drew shots number 11, 1, and 17. As shown in column VIII, Problem 5 (a), these have deviations, respectively,

Shot No.	Deviation +	Deviation −
11		233
1		177
17		430
Sum		840

$$\text{Mean} = \frac{-840}{3} = -280$$

The center of impact is 280 yards short.

The true C.I. (that of the whole group) is −190 yards. Basing our velocity correction on these three trial shots would cause the true C.I. to be adjusted 280 − 190 = 90 yards beyond the center of the hypothetical target.

By Chart A the probability would be reduced to about 30%.

PROBLEM 5 (d)

Assume that seven record shots are to be fired. Draw seven more numbers from the bag. The writer drew Nos. 16, 19, 13, 20, 8, 15, and 10.

Shot No.	Deviations to be Expected	
	True C.I. on Center of Target	True C.I. 90 yds. Beyond Center of Target
8	$-(285-190)=-\ 95$	$-\ 95+90=-\ 5$
10	$-(\ 36-190)=+154$	$+154+90=+244$
13	$-(\ 89-190)=+101$	$+101+90=+191$
15	$-(217-190)=-\ 27$	$-\ 27+90=+\ 63$
16	$-(217-190)=-\ 27$	$-\ 27+90=+\ 63$
19	$-(304-190)=-114$	$-114+90=-\ 24$
20	$-(184-190)=+\ 6$	$+\ 6+90=+\ 96$

Deviations of ± 55 yards give hits. Chance therefore gives us in this string 3 hits (or 43%) if the true C.I. is on the center of the target; and it so happens that we get two hits (or 29%) when the true C. I. is 90 yards beyond the center of the target.

In a long continued string the advantage of having the true C.I. on the center of the target, instead of 90 yds., beyond is apparent.

Increasing accuracy of fire would show the greater necessity of getting the true C.I. on the center of the target.

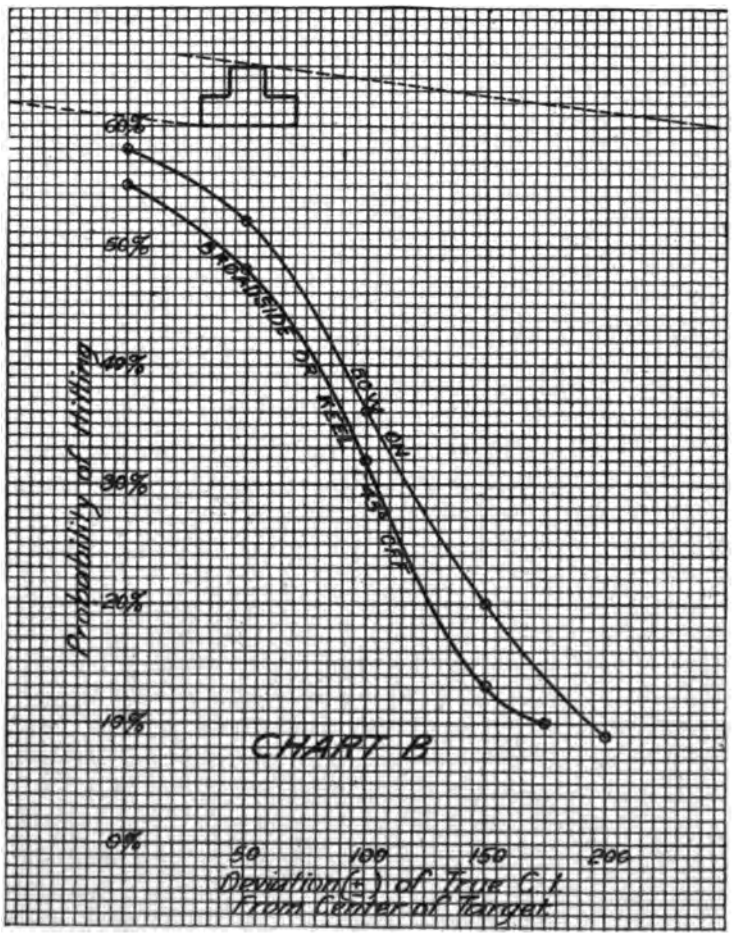
Problem 5 (e)

From the target practice condition let us proceed to the service target. Take, for example, the British Dreadnought *Centurion* and study it as a type target from information to be found in the 1914 edition of Jane's "Fighting Ships." The scale is approximately 1 inch = 100 feet.

Assume the ship to be at 8000 yards and head on to the battery and coming in.

The slope of fall (that is, the natural tangent, ω_ϵ) for this range is 1 on 7.2. Construct this angle on transparent cross-section paper and place the paper over the cut of the ship. By means of this angle we can determine the point on the water which a shot will hit which pierces the rear edge of the barbette of the fourth turret half way up from the waterline. In the judgment of the writer this point was located on the water line at a distance of 440 feet from the front edge of the barbette of the first turret. This approximation of the horizontal target offered by the ship head-on allows for the reduced deck area at the ends of the ship and for the narrow-

ness of the turrets themselves. We cannot expect all our shots to be exactly lined up, and an approximation is all that can be made. The depth of the horizontal target at this range, then, is taken as 440 feet, or 147 yards. Call it 150 yards.



1755

If the center of impact coincides with the center of the horizontal target presented, what is the probability of hitting with this combination of gun, carriage, projectile, powder, etc.?

$$\frac{Z}{Z_1} = \frac{150}{125} = 1.20$$

Therefore the expectancy of hits is about 58%.

Chart B shows how the expectancy varies as the C. I. diverges from the center of the horizontal target presented.

PROBLEM 5 (f)

Compute a probability curve for the same ship broadside-on at 8000 yards. Point of aim on the foremast. Take the top of the target on a line level with the top of the forward superposed turret. The target, including this turret and the fore funnel, is about 100 feet wide and will be broad enough for most of the deflection errors of the piece, etc.

On a piece of cross-section paper construct a cross-section of the ship at this point. A close approximation is all that is necessary. See the figure on the upper part of Chart B. The horizontal target is about 415 ft. or 138 yards, deep.

It will be seen from a similar construction of the target presented by the same section of the ship when the keel makes an angle of 45° with the line of fire that the target is practically of the same dimensions as when the ship is broadside-on. The probability of hitting will therefore be about the same.

So much for the present in regard to the accuracy of this combination of ordnance material and correction devices.

The question naturally arises, what causes may be responsible for the deviation of the center of impact from the center of the target?

Among the most important may be mentioned:

1. Errors in the range table, either for a particular gun or a class of guns. These tables represent principally the $\varphi - R$ relation as closely as it can be approximated from an interpretation of the range firings. It must be remembered that in any range firings it is impossible,—

a. To determine exactly and allow for the true atmospheric density encountered by each projectile along its trajectory.

b. To determine exactly and allow for the true value of the range effect of the wind along the trajectory.

c. To determine exactly the true angle of departure by the jump screen because of the vertical whip of the gun and the consequent velocity given to the projectile normal to the line of departure and in the plane of departure.

d. There are necessarily errors in the assumption of the laws of retardation expressed by any ballistic table on which computations may be based.

2. Errors in the determination of an allowance for meteorological conditions obtaining along the trajectory at the time of each service shot.

3. Errors in range correction charts computed by ballistic tables on more or less approximate data as to the value of the ballistic coefficient, etc.

4. Erroneous assumption of velocity. From trial shots this necessarily includes range table errors; errors in meteorological data; errors of gun and mount (including non-uniform jump); and if the number of trial shots is limited to three or four, their mean muzzle velocity may be materially different from the mean muzzle velocity developed by the shots fired at the target.

5. In the case of the gun itself and disappearing carriage, variations in the quadrant elevation, for a given range setting, due to the unequal expansion of the parts of the gun and carriage with changes of temperature.

6. Errors of the position finding service,—including errors in the plotting of the target and determining the set-forward point for the instant of firing, errors in operation of the correction devices on the information furnished, errors in transmitting firing data, and errors in setting such data at the piece.

The next question might be, "what is the principal significance of these errors?" To the writer, their principal significance is this: by a *sufficient number* of trial shots fired at one range we can determine the deviation of the center of impact from the aiming point and thereby determine the new velocity to be used. The term "new velocity" is understood to mean the determination of the new quadrant angle of departure required by the mount, gun, powder, meteorological conditions, etc., which will cause the center of impact of succeeding shots to have the same range as our aiming point. In our present practice we strive to achieve this by attributing the range deviation of the center of impact to an erroneous assumption of muzzle velocity, and we then determine the muzzle velocity which will give the proper change in the angle of departure. If the number of trial shots represents the average action of the powder, gun, mount, etc., the center of impact of the succeeding shots should coincide very closely with the aiming point if we continue to fire at the same point with the new velocity. But what will happen if we fire at

an aiming point at a different range? Will our shots continue to have their center of impact on any aiming point at whatever range, or will errors in our correction devices, variation of mean jump with variations in the quadrant elevation, etc., cause the C.I. of succeeding groups of shots to diverge from aiming points at different ranges? In other words, if our aiming point be moving, as the foremast of a target coming in, and assuming that for the presentation of the target our center of impact has been further adjusted by the tide curves so as to approximate the center of the horizontal and vertical target presented, rather than the point of observation itself, will our system of fire control and the accuracy of our pieces permit us to keep our center of impact on the center of the target without further correction, even from day to day? This is the fundamental object of our methods, the keeping of the center of impact adjusted. Therefore the refinements in our correction devices in the face of such errors of individual shots as we met in Problem 5. For no pains nor labor nor somewhat complicated calculations should be avoided in our profession when we have an opportunity if we can evolve a system of easily operated devices which will keep our center of impact adjusted from day to day and from range to range.

These questions are somewhat readily put. The answers present great difficulty. It is difficult to formulate any tangible replies. Of the errors heretofore noted the following should not cause any materially effective departure of the center of impact from range to range or from day to day ("effective" is here used as meaning the effect on the probability of hitting as illustrated by Charts A and B by faulty adjustment of the center of impact):

1. Errors in the range table.

2. Errors in meteorological data from properly located stations.

3. Errors in range correction charts based on Table II.

Of the other sources of error:

4. The erroneous determination of the velocity to be used presents a vital question. Will three or four trial shots furnish as good information as ten or twenty in meeting the gunnery, as well as the target practice, problem?

We furnish one range table for all types of 12-inch guns, for instance, and we base all our correction devices on the same set of ballistic tables and the same formulæ, and ignore

so called peculiarities of individual pieces. Would it not be in logical sequence to use all trial shots from at least the same model of gun and carriage in determining the mean "velocity" to be used in any firing with a given lot of powder from guns and carriages of the same model? And better, now that analysis of practice is required, publish the armament and position finding errors for each shot so that each record shot can be incorporated in the study? Also state the height of site of the battery and furnish all the velocity graphic charts to each coast defense for the study? Also let a battery commander, if he so desires, use all of his allowance of ammunition for record firing based on a mean "velocity" for the temperature as determined from the records of previous firings?

It is believed that such a procedure would further the development of knowledge of the gunnery problem. If mistakes are made, analysis will show them up after the firing. The personnel will not suffer in their training, and it does not appear probable that our ability to hit will suffer.

It is believed that such a solution for obtaining the mean "velocity" is in accord with the following statement from *Regulations for the Instruction and Target Practice of Coast Artillery Troops, 1914:*

> The records of firing for several years show that even with careful treatment of powder, with careful blending, with careful handling of the ammunition in the operations of loading, and with careful laying of the gun or mortar in both trial and record shots, it has been impossible to eliminate certain variations in the velocity of the different shots in any group of trial shots or in any series of record shots; these records also show, however, after a careful analysis, eliminating errors which have been made in the firings, that the variations exhibited in any group of trial shots continue practically the same throughout the series of record shots which follows that group; or, in other words, the dispersion of the record shots has been practically the same as the dispersion of the trial shots which furnished the data for these record shots. From this it is seen that the mean velocity of trial shots will be practically the mean velocity of the record shots which follow, and a strict adherence to this velocity throughout the series of record shots will place the center of impact on the target. This is the ultimate purpose of artillery training.

It is here understood that the "dispersions" are measured from the center of impact of the total group (trial and record shots) rather than from the center of impact of the trial shots.

The following issue is raised. There are doubtless many practices where the velocity developed by one or more trial shots have been abnormal, or where the velocities of the trial

shots have not been symmetrically disposed about the mean velocity of the record shots. In either case it is evident that an improper adjustment of the center of impact for the record shots has ensued, although the dispersions of the velocities of the trial shots from their mean may have been practically equal to the dispersions of the velocities of the record shots from their mean velocity. The trouble was that the mean velocities differed.

The basing of a mean "velocity," to be used for a record or service firing, upon a powder study of about 20 or more shots appears to promise the following advantages in the long run:

a. The danger of throwing our center of impact off the center of the target on account of abnormal trial shots, or so-called normal trial shots not symmetrically disposed about the mean velocity to be expected from the powder, is reduced to a fairly small probability.

b. The advantage to be expected from having the center of impact closely adjusted will reach a fuller development, the greater the number of shots allowed for the record string.

c. If this procedure is found reliable, the batteries will be prepared to open fire on a hostile fleet at any time without firing trial shots,—in fact trial shots will be useless or apt possibly to throw the center of impact off the target.

Three methods of adjusting the center of impact present themselves:

a. Use the mean "velocity" developed by trial shots.

b. Incorporate the "velocity" developed by each trial shot in the study of previous shots and take the mean of all shots considered.

c. Fire no trial shots, but use this ammunition for a record string, using the mean "velocity" developed by previous shots.

It may be objected that the "velocity" determined by trial shots just previous to the record string will make better allowance for the meteorological conditions at the time of firing the record string. It is believed that such objection has relatively small value due to the fact that it has been well established that the inaccuracies in our fire are to such a great extent to be attributed to variations in velocity rather than to any other cause. Furthermore when we deal with

the high ballistic coefficients, range deviations caused by errors in allowing for meteorological conditions are much less for a given range than obtains for small ballistic coefficients. On the other hand, range deviations by high ballistic coefficients at a given range due to variations of velocity are much greater than range deviations by small ballistic coefficients under the same variations in velocity. Therefore it is believed that the velocity is the main thing we have to solve for, particularly in firing guns of 10-inch and greater caliber.

Nor does there appear to be any relation between the age of a powder and the mean velocity developed by it.

As regards the range at which trial shots should be fired, perhaps nothing can be said other than that a long range firing will give the best "velocity" in the early stages of an engagement. It might be advantageous to fire them at the elevation for which the carriage gives little or no jump. For a 12-inch D. C., the jump curve on Plate II, JOURNAL OF THE U. S. ARTILLERY, Sept.-Oct., 1911, opposite page 186, or in the Jan.-Feb. issue of 1915, places the quadrant elevation at about 7° 6′+. The point at issue may be illustrated by an example:

PROBLEM 6

Data: 12-inch gun, capped projectile. Height of site, 100 feet. Uncorrected range to aiming point, 4000 yards. Wind reference number, 50. Atmosphere reference number, 16. Tide, 0. Muzzle velocity assumed, 2250. Carriage, D. C., Model 1896. Center of impact coincides with the aiming point.

If we fail to consider jump we will obviously assume 2250 as the velocity for the record string, because the center of impact coincides with the aiming point.

But if we consider jump we will determine another value. By the present method of graduating the range scale (1915) the quadrant elevation to be given the piece will be

$$\varphi_\epsilon = \varphi - \epsilon = 2^\circ\ 28'.2 - 29'.6 = 1^\circ\ 58'.6$$

If we assume the verity of the jump curve already referred to, we see that the mean jump of a group of shots fired with this quadrant elevation is about +4′. The actual quadrant angle of departure of the group then would be expected at about 1° 58′.6 + 4′ = 2° 2′.6; and the angle of departure to the center of impact would be

$$\varphi = \varphi \;\; + \epsilon = 2^\circ\ 2'.6 + 29'.6 = 2^\circ\ 32'.2$$

The true muzzle velocity would therefore be

$$A = \frac{\sin 2\varphi'}{C} \qquad\qquad Z = \frac{X}{C}$$

$$\begin{array}{rlrl} \log \sin 5^\circ\ 4'.4 = & 8.94660 - 10 & \log 12000 = & 4.07918 \\ \operatorname{colog} C = & 9.07103 - 10 & \operatorname{colog} C = & 9.07103 - 10 \\ \hline \log A = & 8.01763 - 10 & \log Z = & 3.15021 \\ A = & 0.01041 & Z = & 1413 \end{array}$$

$$(V = 2200;\ Z = 1413)\ A = 0.01061 \quad \Delta = -0.00047$$
$$(V = 2250;\ Z = 1413)\ A = 0.01014$$

$$V = 2200 + \frac{.01041 - .01061}{-.00047} \times 50 = 2221 \text{ f.s.}$$

Assume that we accepted 2250 as our velocity and opened fire at a target at a range of 11,000 yards. What deviation of the center of impact from the center of the target would be expected?

By our present method (1915) of graduating the range scale,

$$\varphi_\epsilon = \varphi - \epsilon = 9^\circ\ 04'.7 - 13'.1 = 8^\circ\ 51'.6$$

At this quadrant elevation the mean jump to be expected is about $-1'.8$.

Therefore the mean quadrant angle of departure would be about

$$\varphi'_\epsilon = 8^\circ\ 51'.6 - 1'.8 = 8^\circ\ 49'.8$$

This means that the angle of departure would be about

$$\varphi' = \varphi'_\epsilon + \epsilon = 8^\circ\ 49'.8 + 13'.1 = 9^\circ\ 2'.9$$

Remembering that the velocity is actually 2221 f.s.,

$$A = \sin \frac{2\varphi}{C}$$

$$\begin{array}{rl} \log \sin 18^\circ\ 5'.8 = & 9.49223 - 10 \\ \operatorname{colog} C = & 9.10792 - 10 \\ \hline \log A = & 8.60015 - 10 \\ A = & 0.03982 \end{array}$$

$$(V = 2200;\ A = 0.03982)\ Z = 4088 \qquad \Delta = 137$$
$$(V = 2250;\ A = 0.03982)\ Z = 4225$$
$$(V = 2221;\ A = 0.03982)\ Z = 4088 + 137 \times \frac{21}{50} = 4146$$

$$\log Z = 3.61763$$
$$\log C = 0.89208$$
$$\log X = 4.50971$$

$X = 32338$ $\qquad R = 10779$

Therefore we would expect the deviation of the center of impact to be $10779 - 11000 = -221$ yards.

On the other hand had we fired our trial shots at a quadrant angle of elevation of 7° we could expect the mean jump to be negligible, and the divergence of the center of impact from the aiming point would have been more truly attributable solely to a faulty assumption of a velocity for the trial shots, and the divergence of the center of impact from the aiming point would have been a good measure of the degree to which our original assumption was in error. Then in firing at a target as close in even as 4000 yards the error in range to be expected would have been that corresponding to about +4′, or about +100 yards. This corresponds to a vertical error of about +14 feet.

5. Errors in the quadrant elevation due to unequal expansion of the parts of the carriage, droop of the gun, etc. Tests that have been made with a level in the powder chamber and a clinometer at the muzzle indicate that the principal source of the change in quadrant elevation, as indicated by the clinometer, is in the variation of the droop of the gun itself due to unequal heating and expansion of the upper and lower elements, rather than to unequal expansion of the parts of the carriage, which latter effect has been found to be very slight. An excellent discussion of this question of muzzle droop, etc., can be found in an article by Lieutenant H. J. Jones of the British army in *Engineering* of December 30, 1910, and reprinted in the JOURNAL OF THE U. S. ARTILLERY of Jan.-Feb., 1911, (Vol. 35), p. 63. The way to meet this condition would seem to be to establish a reference condition for clinometering the piece and let it go at that. It can be done as follows:

a. Do the work in the early morning before the heat of the day, so as to get the gun at normal droop, when all parts of the gun are at the same temperature.

b. Adjust the clinometer and level each gun when pointing on a line perpendicular to the azimuth Directing Point-Pintle Center. Check the range scale and set the index at this azimuth.

c. Determine and tabulate the angular amount the base ring is out of level + or − at aximuths differing by 5° intervals.

d. Construct a chart showing range differences at long range due respectively to gun difference and the amount the base ring is out of level. This for each 5° interval in azimuth.

e. By chart (d) it may be seen that the respective range indices may be shifted for a flat correction without appreciable error, or new "Gun Differences" may be used.

Two of the important inferences that may be drawn from Lieut. Jones' article are:

a. That under the great internal pressure while the projectile is in the bore, the tube will tend to straighten, and the amount the droop has been taken out at the instant of departure is difficult of determination.

b. The effect of the vertical whip due to the vibration set up as the gun straightens may make refinements in clinometering (corrections for temperature) appear unimportant in really improving accuracy. It would appear that all that is productive of *uniformity* is to establish a reference for the general gunnery condition, and not for a particular target practice condition.

6. Errors of the position finding service can only be eliminated by careful drill and checking up of drills. It is the possibility of such errors creeping in during firing that presents a strong argument for a rigid system of fire control and sticking to it rather than to rely on correction of fire from observation. *Correction of fire from observation depends absolutely among other things upon correct laying;* but by following a more or less rigid system of fire control based upon a number of previous shots an error of laying causes possibly a miss only in one shot and does not cause a shifting of the center of impact by making a correction after having observed the fall of an erroneously laid shot. And there is as much chance of a continuing error in the one system as in the other.

The first thing is to determine the actual set-forward range of the target for firing at any instant. However this may be accomplished there is always the opportunity for misjudging the course of the target and making an error in predicting its range. This is so even with perfect information from the range finders. When this information is imperfect the situation is aggravated. The combinations in tracking are so numerous that the training of a plotter is never ending. But even with a target following a sinuous course where the

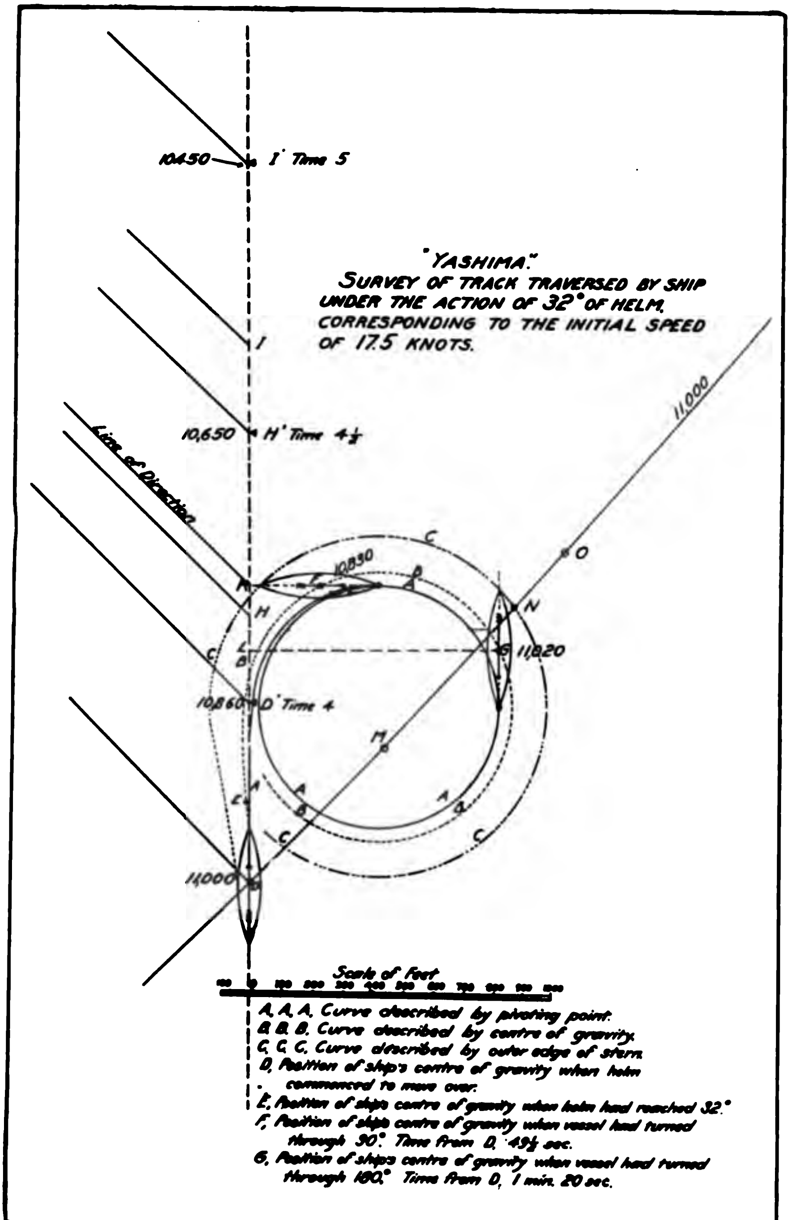

"YASHIMA."
SURVEY OF TRACK TRAVERSED BY SHIP UNDER THE ACTION OF 32° OF HELM, CORRESPONDING TO THE INITIAL SPEED OF 17.5 KNOTS.
10450
I' Time 5
I
10,650
H' Time 4½
Line of Direction
11,000
O
N
10,830
G 11,020
10,860
D' Time 4
M
11,000
Scale of Feet
A, A, A, Curve described by pivoting point.
B, B, B, Curve described by centre of gravity.
C, C, C, Curve described by outer edge of stern.
D, Position of ship's centre of gravity when helm commenced to move over.
E, Position of ship's centre of gravity when helm had reached 32.°
F, Position of ship's centre of gravity when vessel had turned through 90°. Time from D, 49½ sec.
G, Position of ship's centre of gravity when vessel had turned through 180.° Time from D, 1 min. 20 sec.

FIG. 8.

1756

error of prediction probably will lie first on one side of the true position and then on the other side, the effect on the probability of hitting with one type of mount and gun and one lot of powder is shown by Charts A and B. For an error in the determination of the actual range will cause a shifting of the center of impact by sensibly the same amount. But the deviation of the center of impact from the center of the target due to faulty prediction will disappear the moment the prediction becomes accurate.

Until we have exhausted our ingenuity and must admit *and can prove* that our present system does not fairly meet the gunnery part of the coast defense problem, it would seem to be wise to seek not a panacea for gunnery ills in other expedients.

Fig. 8 will illustrate an extreme condition which may arise. The figure is adapted from Plate VII, between pages 954 and 955 of Vol. XXIV, *The Encyclopaedia Britannica*, eleventh edition. The *Yashima* was the sister ship of the *Fuji* and was sunk by a mine off Port Arthur on May 15, 1904. Battleship, 1st Class; date of launch, Feb. 1896; built at Elswick; displacement, 12,320; speed, 18 knots; armament, 4 12-in., 10 6-in., 16 12-pdrs., 4 3-pdrs., 4 2½-pdrs.

Attwood in his book *The Modern Warship* states as follows regarding the trials of the *Lord Nelson:*

* * * In one case the speed of 17½ knots when putting the helm over was reduced to eight knots when on the circle, the engines still running at the revolutions for the 17½ knots.

He also gives the following definitions:

The Advance, i.e., the distance from the position when the helm is put over until the ship turns through 90 degrees or at right angles to her original course.

The Tactical Diameter, i.e., the distance between the center line of the ship when the helm is put over until she has turned through 180° i.e. with the course reversed.

The information tabulated on opposite page is to be found on page 956 of *The Encyclopaedia Britannica*.

The factor of 2.7 is typical for the dreadnoughts and battle cruisers of British design. In spite of their greater length this small factor is secured by the use of two balanced rudders and a hull so cut up at the stern as to secure the greatest turning advantage.

Referring to Fig. 8, we will make the following assumptions:

a. That the ship has been running on a straight course at a speed of 17½ knots until it arrives at the position *D*, when the helm is started over to 32°.

b. That a 30 second observing interval is being used.

c. That the set-forward point is located ahead a distance equal to the travel during the past minute + time of flight.

d. That the range of the target at the position *D* is 11,000.

e. That the battery is equipped with 12-inch guns and capped projectiles, for which the time of flight is 20 seconds.

f. That the ship is at the position *D* on the bell at time 4.

Ship or Class	Displacement in tons	Length in ft.	Speed in knots at commencement of turn	Advance in yards	Tactical diameter in yards	Tactical diameter divided by length
Dreadnought	17,900	490	19	490	440	2.7
Lord Nelson	16,500	410	17	400	370	2.7
King Edward VII	16,350	425	16½	450	440	3.1
Formidable	15,000	400	14½	440	500	3.7
Majestic	14,900	390	16	450	500	3.9
Minotaur	14,600	490	19	480	600	3.7
Monmouth	9,800	440	23½	590	790	5.4
Drake	14,100	500	23½	700	810	4.9
Diadem	11,000	435	20½	650	920	6.3
Powerful	14,200	500	22	800	1120	6.7
Minerva	5,600	350	18	540	770	6.6
Arrogant	5,750	320	17	350	380	3.6

The lines of direction are shown in Fig. 8.

We would then have the following established:

a. The set-forward point as located from *D* would be at *I'*, the expected position of the ship 1 min. 20 secs. after the bell.

b. *H'* would be the set-forward point located 30 seconds earlier, i.e., at time 3½, and expected to be good at time 4½.

c. *D'* would be the set-forward point located 1 minute earlier, i.e., at time 3, and expected to be good at time 4.

The time range relation is shown in Fig. 9.

If the guns were fired at time 4 (for the range to *D'*), there would be no appreciable error.

If the guns were fired at time 4½ at a predicted point *H* but for the range to the set-forward point *H'*, the target would

be at F (Fig 8). The range error would be 10,650 − 10,830 = −180 yards. By chart B the probability of hitting would be reduced approximately from 55% to 9%. The chart however was constructed on the probable error at 8000 yards on a larger target, so the *loss* in probabiltiy at the greater range and smaller target would not be so great as here indicated.

An equivalent error for 10-inch guns and capped projectiles, with the double section charge, would reduce the probability of hitting from about 12% to 11%. Using the single section core igniter charge the probability would have been reduced from about 36% to 7%. See the curves for Series I and Series II, respectively, on Chart D.

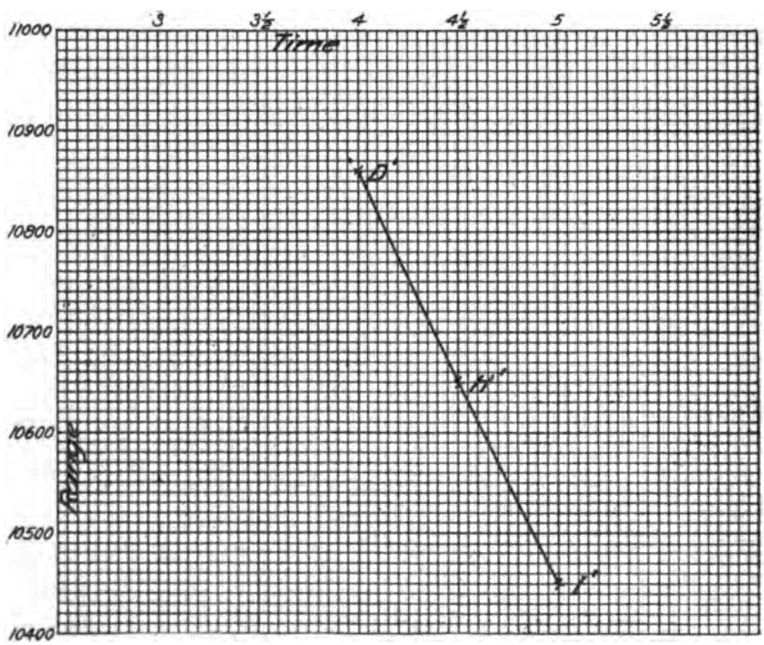
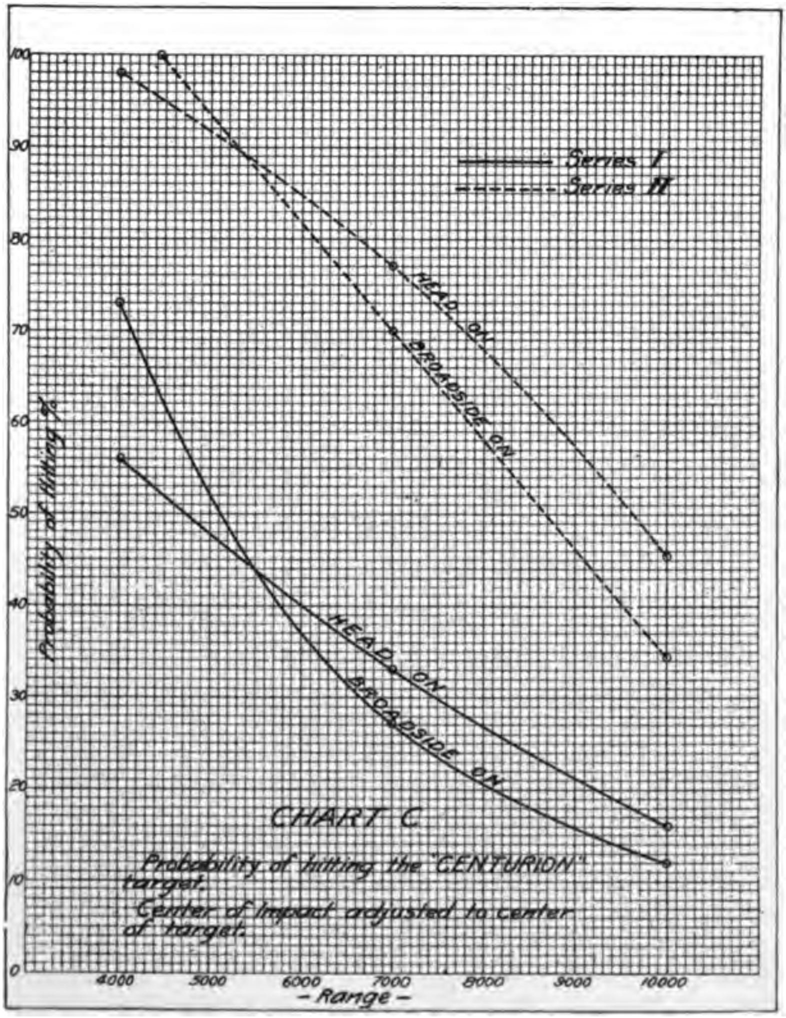


FIG. 9. 1757

If the guns were fired at time 5 at a predicted point I for the range to I' as shown by the time range relation curve, the target would be at the position G. The range error would be 10,450 − 11,020 = −570 yards, and the probability of hitting would be approximately zero.

For the deflection problem we will assume, for simplicity, that the lateral effect of the wind is such as to neutralize the drift. Then when the point D is plotted at time 4, the

angular travel correction will allow for a movement of the target equal to the distance DM, approximately the same as during the interval preceding D. If the deflection solution is worked out from the angular travel as indicated by the tally



1758

dials on the gun arm center, the deflection will arrive at the guns and be set approximately 25 seconds after time 4, when D was plotted. If the guns are fired at time $4\frac{1}{2}$, the target will be approximately in the direction of H, and the direction at which the shot will be expected to hit will be on a line with N, while the target will be at F.

If the pieces are fired when the target is at *F*, the direction of the splashes will be expected to be at *O*.

This, of course, is an extreme condition, and perhaps the most serious for our methods of gun position finding. If the target follows a sinuous course, the evils will appear to a lesser degree, yet still to an extent to be serious. But even a cursory glance at the problem will reveal some of the difficulties which will confront a battery commander trying to correct his fire intelligently and effectively by any system of observation. The center of impact may be following the position finding exactly, yet the fall of the shots may be away over or away short, away right or away left. Under these conditions the battery commander would not be justified in correcting his fire at all, either in range or deflection with respect to the target at *G*. The only justifiable correction would be with respect to the point I', and not with respect to the point *G*. It is the province of the plotter to adjust I' to *G*, or H' to *F*.

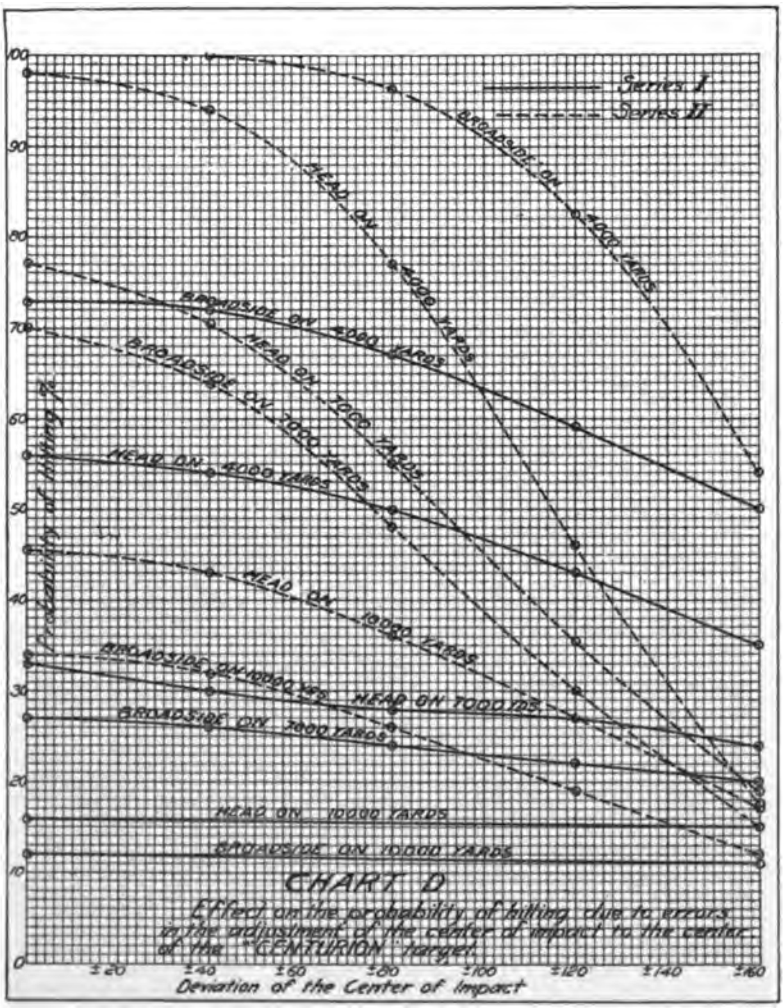
What is the answer?

Probably none. The gunner should know his ballistics sufficiently to understand his position finding matériel and how to repair or replace damaged parts, even by constructing new ones when necessary. Ballistics is the *a priori* work for the study. Gunnery is an approximate problem presenting innumerable aspects, requiring devotion both in the study and in the face of the enemy.

The answer will come from the gunners. At best it will be an approximate solution, but the gunner works in approximations. The best gunner is the one who can make the closest estimate. It will come from the men who make the drill period a time of investigation, of study, not being content to approach it merely as routine. The one will say "this system of position finding is susceptible of making an error of as much as 100 yards, the error is excessive and not to be contemplated. The system is defective and should not be used." The gunner will say "this system keeps the error within 100 yards, and at worst will cause only such and such a loss in the probability of hitting. *On the average* it is *sufficiently exact*, it meets the general gunnery problem with close answers under all conditions rather than under a few conditions, therefore it is acceptable."

One answer which will immediately appear advantageous is to reduce the observing interval, so that if the target changes

course the prediction of the set-forward point will not be in error to such a great extent. It is obvious that if the observing interval was reduced to 15 seconds, not only would the set-forward points be located so much closer to the *true range*



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of the target turning off the course, but the changes in the course of the target would be apparent from the plotting so much sooner. And if the plotter was informed by information from the B.C. as to the direction of the movement of the target when changes became apparent, the value of such information is obvious. It would immediately aid him to

predict the set-forward point to approximately the range of the target at the end of the time of flight, *shifting*, if necessary, set-forward points *previously determined.* The question of the utility of the *precision* of the instruments he may use for predicting becomes secondary to the *results* which he may secure by free-hand methods. These should be investigated from the standpoint not of so many yards error, but as to the *probability of hitting.* Heretofore our methods of plotting have been such that if the range and deflection during drill or target practice reached the emplacements within 25 seconds after the bell the rapidity of the personnel was average. How then can the interval be reduced to 15 seconds?

Reference to Fig. 8 will convince one that for a rapid change in the course of the target two errors were made, one for range and one for deflection. Are not the two solutions independent, and if so would it not be an advantage for the solution of each if they were handled independently? Under the provisions of our drill regulations the two were solved independently during a recent student officers' target practice as follows:

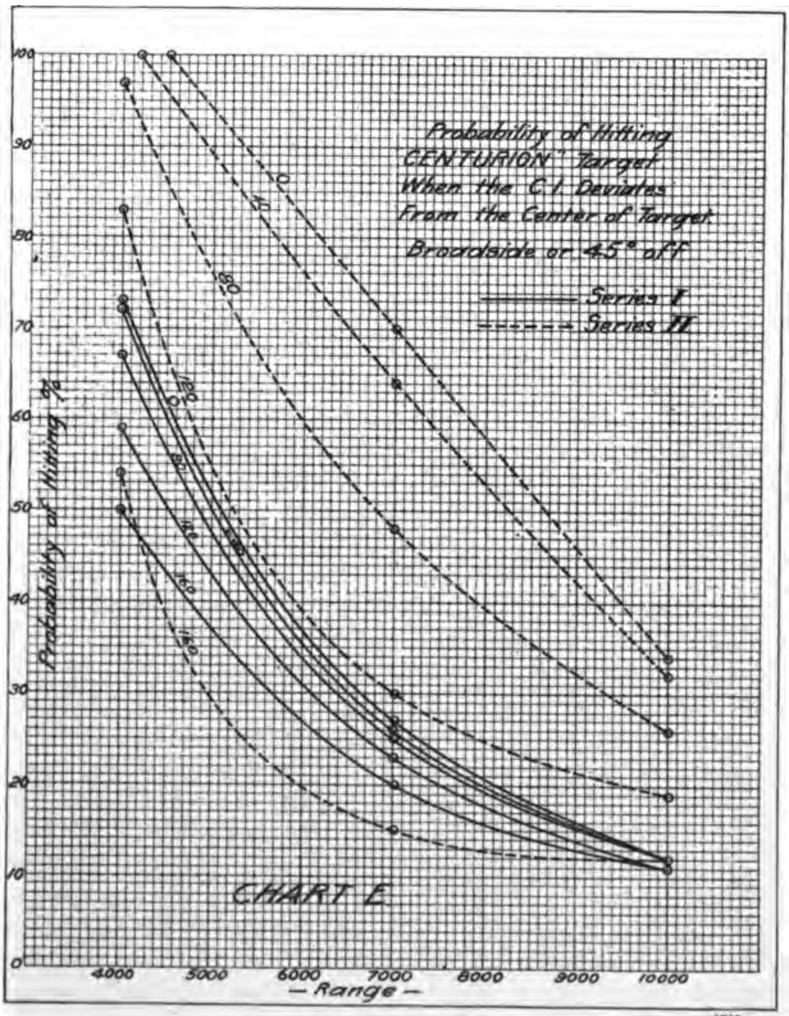
a. The angular travel of the target was obtained by the B.C. instrument, the difference in the azimuth of the target at the successive bells being converted into reference numbers by a conversion ruler. The deflection board was located in the B.C. station and the approximate range and wind component were furnished frequently. Time to get the deflection to the guns was within 15 seconds.

b. The plotting board was used solely for the determination of the range problem. The time required to get the set-forward range was within 15 seconds. The plotter was not encumbered with movements of the gun arm for deflection purposes, nor did the deflection solution wait on that for the range. They were simultaneous and independent. The plotter was free to study the track between bells, and with sufficient training could have changed his information with changes in the course of the target upon later information from the B.C. or other station.

The battery commander was free to exercise that general supervision over the battery which is his proper province, and was not tied down to an instrument. The angular travel observer also caught the deflection errors and gained from subcaliber practice that judgment as to when to correct, and

when not to, which is so necessary to anyone authorized to handle any correction.

All elements of the plotting room work were operated by student officers themselves after only about 10 days' drill. It



is believed that equally good results should be secured by the average section during the time for training at their disposal.

It would appear that a little more thought concerning the movements of the tugs during drill would repay the attention by evolving a method of using our matériel to the best advantage. Why not have the tug maneuver each day so as to

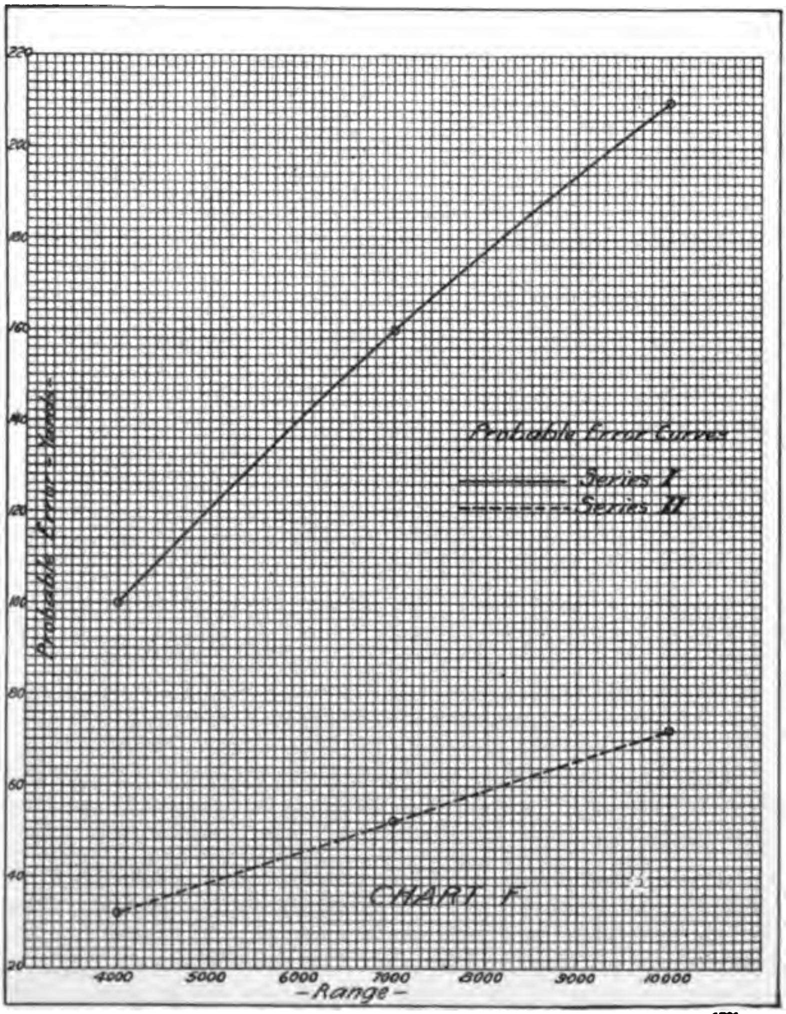
present a given problem? Let it go out with instructions to go through certain evolutions to see how the batteries handle the situations. The tug need not spin around within its capabilities to do so, but should follow a course as it would be traced by a ship of a given type. The movements of the tug and its changing presentations would offer excellent practice for the B.C. personnel in informing the plotter as to the changes in the direction of the course, so that coordination in this very important phase of gunnery work would be developed. In some ways this would be superior even to target practice in training for action, because the type target we now use offers no indication at all to observers as to the direction in which it is going—all that information must be secured entirely from the plotting itself, which is subject to more or less error, and the plotter must work without the control secured from those able to see where the target is going and whenever changes in direction are made.

There is not going to be any exact solution in the usual case for a target on a sinuous course, so the method of tracking should be such as to permit rapid changes in data whenever necessary to keep the set-forward ranges sent to the guns approximated to the range of the target at any instant without throwing the range section into confusion. If a junior officer does at least some of the plotting in person he will have riper judgment in controlling fire when he takes command of a battery. Surely there should be two or more persons in the range section trained in order to replace casualties. It is hoped that the curves exhibited herewith will show the futility of the plotter's wasting good time over a matter of 25 yards or so in locating a set-forward point, time which would be far better spent often in getting the *direction* of the target properly determined, even though relatively crude methods are used to get the set-forward distance along such a course. Would he not be a most excellent plotter who never made less than a 50 yard error, provided he never made a greater error than that! There is a limit to the necessity for refinement, but it is vitally necessary that errors be kept within certain limits.

The following procedure is suggested:

1. The battery commander to train his personnel in such a manner that during practice or action he can devote his whole time to that general supervision and control of the

battery which is his principal duty. For him to dabble in corrections when there are others in a better position to make them is to endanger the success of the team as a whole. In action he will probably have his hands full in keeping the personnel in hand and working smoothly.



1781

2. The deflection solution (and the azimuth solution for Case III) and corrections from observation of fire to be worked out in the B.C. station, under a trained observer. In case the B.C. is knocked out, means should be at hand for working out the azimuth solution in the plotting room.

3. The range solution to be worked out on the plotting board, and range board.

4. The time range device to be sufficiently elastic in its operation to permit changes in data. To illustrate:

See Fig. 8. Assume that at about time 4½ the observer in B.C. informed the plotter that the target was turning to 10 o'clock (the convention being that the line 6 to 12 o'clock is taken along the gun arm, with 6 nearest the gun arm center, and the clock face up and with the center of the face over the target). The plotter might then see that the point *H* should not plot on the straight line, and furthermore he might change set-forward points *H'* and *I'* to positions along the new direction of the target, and send the new ranges to the time range device. Some such method might meet the usual changes of direction of a target with sufficient accuracy.

5. Range setters to set what they receive, no matter what they may think about its being in error due to jumps in data. No time range relation to be kept at the range scale on the gun.

6. The adjustment of fire to be handled under its two constituent heads:

a. The plotter to strive to keep the set-forward points adjusted to the track of the target.

b. The range officer to receive information as to the range of the shots and to make corrections so as to adjust the fire to the set-forward points as plotted.

Observation of Fire

This is often spoken of as an alternative for our present methods. Before we go any farther, let each one who is whole hearted for observation of fire ask himself how far he has investigated the probability of hitting of his battery as demonstrated by previous firings. The study of the probability of his battery and position finding service is fundamental to success in observation of fire. Without the knowledge of when a deviation from the target exceeds the probable error and when a deviation is less than the probable error the observer is quite at sea. The writer fails to see how a correction of fire based on rough, hasty approximations of distances over or short will get more accuracy out of our matériel than the thorough study before firing of a large number of deviations accurately measured. Before we go to observation of

fire, these two questions must be answered authoritatively in the negative:

1. From a study of *a number* of previous shots with a lot of powder, can we approximate the center of impact to the center of the target with sufficient exactness?

2. With our center of impact adjusted for one range, will our correction devices and range finders keep the center of impact adjusted with sufficient accuracy from day to day and from range to range?

The following discussion is quoted from *Drill Regulations for Coast Artillery, United States Army, 1905, Gunnery:*

Correction of Fire

20. In war service, as well as before target practice, it will always be possible to test the powder charges by a few trial shots; and even after the action commences it will usually be possible, except at night, to observe fire with fair accuracy at the longer ranges. At the mid and short ranges it will often be impossible for a battery commander to distinguish the splash of the shots from his own battery from those of other batteries. Whenever it is possible to observe the fall of a projectile or the center of a volley and it is found that the fire of the battery is inaccurate, the shot or center should be plotted in case the location of the shot cannot be determined sufficiently accurately by the instrument for the observation of fire, and correction should be made from the observed fall of the shot or shots. It is better to lose the time required for observation of fire than to lose the entire work of the battery by inaccurate pointing.

21. *To distinguish inaccurate practice.*—The gun having been properly pointed according to the data received, the presumption is that the gun is accurately pointed and that if a number of shots could be fired at the same point with the same pointing the center of impact of the shots would be on the target. All the shots should fall in the total target rectangle, 25% in the 25% target rectangle and 50% in each of the target zones. If the first shot does not fall in the total rectangle the pointing is *manifestly inaccurate* and correction should be made for the next shot in accordance with the rule given on page [60]. If the first shot falls within the total target rectangle there is no certainty that the pointing was accurate; if however a number of shots fall within this rectangle the probability is in favor of accurate pointing. This is specially true if the shots are distributed about the target, some beyond, some short, some to right and some to the left. If these conditions obtain, the pointing should be assumed to be accurate and no further corrections should be made. If, however, the shots all apparently go to the right, or all to the left, or all beyond or all short, or a majority appear to fall on the same side of the target, the presumption is that the pointing is inaccurate. In such cases corrections should be made according to the rule.

If the target is larger than the total target rectangle it should be hit every time if the gun is accurately pointed. If, however, as is usually the case, the target is smaller than the total target rectangle it cannot be ex-

pected that it will be hit every time even with the most accurate pointing. If the pointing appears to be accurate no alteration should be made simply because the target is not hit as such alteration might throw the center of impact entirely off the target.

It is important that the idea expressed by the *center of impact being on the target* should be understood. For each laying of the gun there would be, if a large number of shots were fired under the same conditions, a *sheaf of trajectories* as shown in Fig. [4]; each sheaf contains a mean trajectory which passes through the center of impact. During practice every shot fired belongs to some sheaf; when it is said that the center of impact is on the target, it is meant that the mean trajectory of the sheaf to which the shot belongs passes through the center of the target; therefore the gun is correctly laid.

In establishing a rule for correction of fire based upon mathematical principles it is not expected that such a rule can be accurately used during action. It can be used during target practice and when correcting from the results obtained by the trial shots. It is important that every officer should be trained in observing fire and in properly correcting therefrom. Whether the corrections are made from accurate plotting of the shot as when correcting from the trial shots, or by rough estimation as would probably be done in action, it is important that such corrections should be based on sound principles. The rule is therefore given as a basis upon which each officer should endeavor to train himself for this important work. Gunners should also be instructed in this important subject.

When firing at a fixed target the corrections of fire are made for the actual deviation in yards. This cannot be done when firing at a moving target. In the latter case all range deviations are assumed to be due to variations in muzzle velocity and the markers on the range board are changed for a variation in velocity corresponding to the observed range deviation of the shot or a fraction thereof. All lateral deviations are assumed to be due to variation in wind or to an incorrect estimate of the force of the wind over the range, and corrections are made by changing the reading of the wind velocity corresponding to the lateral deviations observed or a fraction thereof.

Rule for correction of fire.—Point the gun for the first shot according to the range tables as determined by the range and deflection boards. Note the longitudinal and lateral deviations.

Correct the pointing of the *second shot* for the full deviations of the *first shot.*

Correct the pointing of the *third shot* from the pointing of the *second,* by *one-half the deviations of the second shot.*

Correct the pointing of the *fourth shot* from the pointing of the *third,* by *one-third the deviations of the third shot.*

Generally;

Correct the pointing of $(n+1)$ shot from the pointing of the *nth* shot, by $\frac{1}{n}$ of the deviations of the *nth* shot.

By this process the center of impact will be brought closer and closer to the center of the target.

Of course it would be useless to carry this process to an extreme. Judgment must be used in determining when to stop making corrections. If a

shot falls within the 25% target rectangle no correction should be made until it is manifest that the pointing is incorrect. If the first shot falls within the total target rectangle but not within the 25% target rectangle it will usually be wise to correct for the full deviation, if the second shot also falls within the total rectangle but without the 25% rectangle it will be wise to correct for half the deviations; after which whether any further corrections should be made, must be determined by a consideration of the fall of the shots fired.

In action if an officer notes that the shots are all going beyond the target he must estimate the deviation if possible and correct according to the rule. The same is true if a majority of the shots are falling short or to the right or left. If however the shots strike all around the target no correction should be made although the target itself is not hit.

Unless there is good reason for rejecting a trial shot, determine the mean longitudinal and lateral deviations of the trial shots, and make a *full correction* corresponding to this mean for the first record shot, after which proceed according to the rule for correction of fire.

The application of this rule to fixed and moving targets is the same except that in the latter case the corrections are made on the range and deflection boards as already explained.

Demonstration of the Rule

22. The object of the rule is to establish a method by means of which the center of impact may be made to coincide with the center of the target. This could be readily done by firing a number of trial shots with the same laying, then determining the center of impact of the group and correcting the laying to correspond to the deviations of this center of impact from the target. By means of the rule we do this very thing, making partial corrections for each shot. The principle is true whether the shots fall short or go beyond the target, but for the purpose of explanation it will be assumed that all of the shots fall short of the target. This will avoid the use of the plus and minus signs in the discussion.

Fig. 10.

The discussion will be given only for range deviations it being manifest that the same principle holds for lateral deviations.

In Fig. [10], let T represent the target the direction of fire being from left to right. The range from the gun is R yds. Assume that the atmospheric conditions are normal and zero wind.

For the first shot the gun is laid for R yds., according to the range tables; suppose the shot falls at A, being a yds. short; that is $AT=a$. The actual range of this shot is $(R-a)$ yds.

Based upon the only information at hand the gun must be laid for the 2nd shot for $(R+a)$ yds.; now suppose the shot strikes at B, which is b yds. short, that is $BT=b$. The actual range of this shot is $(R-b)$ yds., but it was laid for $(R+a)$ yds., therefore it fell short of the point for which it was laid $(a+b)$ yds., as $(R+a)-(R-b)=a+b$.

Had the 2nd shot been laid for a range of R yds., instead of for a range

$(R+a)$ yds., it would presumably have fallen $(a+b)$ yds. short of the point for which the gun was laid, that is its range would presumably have been $(R-a-b)$ yds. The shot would have fallen at some point B'; b yds. short of A.

The actual range of the 1st shot laid for a range of R yards is	$R-a$ yds.
The presumable range of the 2nd shot laid for a range of R yards is	$R-a-b$ yds.
	2) $2R-2a-b$ yds.
Mean range =	$R-a-\frac{1}{2}b$ yds.

The center of impact of these two shots is therefore $(a+\frac{1}{2}b)$ short of the target and the proper corrected laying is $(R+a+\frac{1}{2}b)$, but the first shot was corrected and laid for $(R+a)$ so that the additional correction for the third shot is $\frac{1}{2}b$. That is, the 3rd shot must be corrected from the second by $\frac{1}{2}$ the *deviation of the second* as per rule.

The 3rd shot is then laid for $(R+a+\frac{1}{2}b)$ yds., and suppose it falls short c yds. Its range is therefore $(R-c)$ yds., that is, it fell $(a+\frac{1}{2}b+c)$ short of the point for which it was laid. Had it been laid for R yds., its range would presumably have been $(R-a-\frac{1}{2}b-c)$ yds.

Actual range of 1st shot laid for a range R yards is	$R-a$ yds.
Presumable range of 2nd shot for a range R yards is	$R-a-b$ yds.
Presumable range of 3rd shot laid for a range R yards is	$R-a-\frac{1}{2}b-c$ yds.
	3)$3R-3a-\frac{3}{2}b-c$ yds.
Mean range =	$R-a-\frac{1}{2}b-\frac{1}{3}c$ yds.

The center of impact is therefore $(a+\frac{1}{2}b+\frac{1}{3}c)$ yds. short of the target and the proper corrected laying for the next shot is $(R+a+\frac{1}{2}b+\frac{1}{3}c)$ yds., but the 3rd shot has already been corrected for $(a+\frac{1}{2}b)$ therefore the additional correction is $\frac{1}{3}c$. That is, the 4th shot must be corrected from the third by $\frac{1}{3}$ of the deviation of the third as per rule.

By the same process of reasoning the following general expression is obtained for *correction of fire.*

$$R \pm a \pm \tfrac{1}{2}b \pm \tfrac{1}{3}c \pm \tfrac{1}{4}d \pm, \text{ etc.}$$

In which R is the range to the target and a, b, c, d, are the successive observed deviations. The formula applies whether the deviations are longitudinal, lateral, horizontal or vertical; the plus sign is used when the shot falls short, and the minus when the shot falls beyond the target.

Suppose that the 5th shot was to be corrected from the 1st shot, the proper corrections to be made would be $(a \pm \frac{1}{2}b \pm \frac{1}{3}c \pm \frac{1}{4}d)$. If, however, as is usually the case, the 5th shot is to be corrected from the 4th the only correction to be made is $\pm\frac{1}{4}d$.

In case a number of shots have been fired under the same conditions and with the same laying and it is found necessary to make a correction, the proper correction to be made is equal to the mean deviation of all of the shots fired under the same conditions.

Thus suppose all of the four shots considered had been fired with the same laying, that is, for a range of R yds., the deviations would have been as follows:

Deviation of 1st shot	$+\ a$
Deviation of 2nd shot	$+\ a+\ b$
Deviation of 3rd shot	$+\ a+\frac{1}{2}b+\ c$
Deviation of 4th shot	$+\ a+\frac{1}{2}b+\frac{1}{3}c+\ d$
	$4)\ +4a+2b+\frac{4}{3}c+\ d$
Mean deviation =	$+\ a+\frac{1}{2}b+\frac{1}{3}c+\frac{1}{4}d$

Proper correction for the next shot is therefore $R+a+\frac{1}{2}b+\frac{1}{3}c+\frac{1}{4}d$ which is the same as that determined by making the partial corrections for each shot by the rule. Of course it is not certain that the center of impact of the four shots fired exactly coincides with the center of impact of the sheaf to which they belong, therefore while the above correction for the 5th shot will make the center of impact of the shots coincide with the center of the target it is not certain that the center of impact of the sheaf is on the target. As the number of shots increases the nearer will their center of impact coincide with the center of impact of the sheaf and the more accurate will be the laying. The rule therefore prescribes a method of correction of fire which will bring the center of impact of the sheaf closer and closer to the center of the target and therefore continually increase the accuracy of laying.

The foregoing rule should be applied so as to adjust the fire to the uncorrected range for which the piece was pointed for each shot, and the attempt should not be made to adjust the fire with respect to the target. The plotting must be relied upon to adjust the set-forward points to the target.

Firing at a Moving Target

24. In the preceding discussion upon the correction of fire, it has been considered that the gun was pointed at a definite target. When firing at a moving target the gun is not pointed at the actual target, but is pointed so as to hit a point on the water which is located by *a range and an azimuth.* This point is called the *set-forward point* and may be actually located, as in Case III, or allowance made on the sight, as in Case II, so that the shot will hit this point as the moving target reaches it. In either case the gun is directed on the set-forward point and not on the moving target.

In correcting for fire the deviations of the point of impact must be taken from the set-forward point which is the true target, and not from the moving target which may or may nor be at the set-forward point when the shot strikes.

The lateral deviation can sometimes be measured with fair accuracy by means of the instrument for observation of fire in the primary station and generally with accuracy by the azimuth instrument in the battery commander's station, as the latter is usually nearer the line of fire. The determination of the range deviation is more difficult. In case of trial shots when the point of impact is plotted, the range deviation is the difference between the actual range for which the gun was laid and the plotted range

of the shot. Except on high sites the range of a shot measured by the Type "B" instrument for observation of fire cannot be relied upon for correction of fire. The *difference in range* between the range of the target and the range of the shot can, however, be measured with considerable accuracy at short and mid ranges; at long and extreme ranges it is doubtful whether accurate measurement can be obtained with the Type "B" instrument even on sites of considerable height. From sites of low or medium height it is impracticable to measure this range difference at all at the extreme ranges as the target is too near the horizon.

It must be remembered, however, that the range difference thus obtained is not necessarily the range deviation of the shot since it includes the deviation of the point of impact from the set-forward point and the deviation of the target from the same point. Generally by observing the plotted track the range officer can judge as to the accuracy of the prediction made and he should endeavor to determine during drill the probable error of prediction of his position finding service; knowing this he can usually judge how much of the range difference he should correct for.

Under no circumstances, when it is possible to use an instrument, should an officer ever rely upon a range deviation estimated by the eye; it is almost invariably deceptive, especially if the shot is not a line shot. During action at the short and mid ranges it will as a rule be impracticable to use an instrument for observation of fire, therefore officers should take advantage of every opportunity to practice observation of fire by the eye. The eye can be trained to judge deflection with considerable accuracy, and it may be possible to train the eye for range deviations at the shorter ranges. Each officer present at artillery practice should estimate the deviations of every shot fired, recording the same in a note book and comparing his estimate with the plotted record. Gunners should be thoroughly instructed in observation of fire.

It should be impressed upon every artillery officer and gunner that accuracy in artillery practice depends to a very great extent upon *accurate* observation of fire.

Let us look at observation of fire from the target practice standpoint. With our present hypothetical target, how can one observe overs and shorts? By plotting them by the use of observations from the stations? This can be done with sufficient accuracy. Then for the deviation of each shot the rule given in the quotation can be applied. For a range of say 8000 yards the time of flight is 13 seconds. Add 47 seconds to plot the shot and determine its deviation and get a new setting at the gun. One minute between shots with an excellently trained personnel. And when it comes to action we have a material target to track on. No overs can be plotted, if they are lined up with the target. Only those short can be observed. Will confusion in the system arise at this point?

The alternative may be a material target. A truly material target, and one which presents a solid screen to the

view, not a net. The navy type would be satisfactory. One costs $9,300.00. Its draught is 24 feet. In how many harbors could this target be towed for practice with safety? Would not the course of the target be limited to the channel usually? Where are we going to get the power to tow such a target?

Assume that we have such a material target, how is the observation of fire to be carried out? By single shots or by salvos? Are our batteries properly grouped for salvos? A salvo of four shots might give some idea of the location of the center of impact of the group. But even where the arrangement of the batteries permits salvo fire often there is not sufficient height of site to observe from. How long does it take to train a spotter? Will a change of station render training useless? When we discuss correction of fire from observation, let us remember the vast difference involved between correcting on single shots and correcting on salvos. Consider also the well-nigh insurmountable difficulty when the firing batteries have different lots of powder.

Let us now approach the battle condition. Imagine ourselves in the battery commander's station. The type target has been assigned. Assume it to be coming in and at a range of about 12,000 yards and that we are fortunate enough to have a height of site of 100 feet at our station. It appears as a large gray bulk. We assign the target to the observers and gun pointers who take the forward funnel as the point of observation. We have already made a study of the powder to be used. We use the mean "velocity" as determined by all firings we have of record with that lot. Assume that our battery consists of 2 12-inch, Model 1895, guns, on Model 1896 D. C., that we are firing capped projectiles, and that our lot of powder is Int. No. 29, 1910. How are we going to judge whether we are getting hits?

From our curve for the adjustment of the center of impact to the center of the target when plotting on the forward funnel of the type target, we order the tide correction to be increased by a given number of feet.

Then we watch the fall of the shots.

What criterion of accuracy have we? We have the probable error for 8000 yards which can be taken as sufficiently exact for the long range work. (See Chart B.) We have seen that the probability of hitting is 58%. We can expect 42% misses; of these one-half should be over (which we cannot

see) and one-half should be short. Therefore we should expect about 21% short. That is, if about 1 out of 5 shots are falling short we can rest as secure as we can by any other method that our center of impact is on the center of the target. If a greater number than this out of the first ten shots went short, there would be a temptation to apply an arbitrary correction. The idea of 100% of hits should be avoided like the plague. One out of five or six short is good insurance.

Similarly, for the type target broadside-on or with the keel making an angle of 45° with the line of fire. We see that the probability of hitting is 55%. We can expect 45% to be misses when the center of impact coincides with the center of the target. Therefore we can expect 23% to fall short. Here we have the rough rule again of 1 out of 5 short. Some such simple rule is applicable both to night and day firing; it requires no *quantitative* determination of overs and shorts, which is extremely difficult of attainment; and it is about all that a battery commander could remember in the heat of an action when there are sure to be so many other calls upon his attention.

By the method suggested we are depending heavily on a previous powder study. At least this study offers the advantage of approximating our center of impact to the target immediately, with the consequent benefit of possibly a small correction instead of a great one, in order to complete the adjustment. To develop the method to its logical conclusion the advantage of having a battery, or like batteries in a fire command, furnished with only one lot of powder is readily seen. There would be no need to change the "velocity" reference number during an engagement, with the chances of error introduced in the excitement. And if sufficient of the lot was on hand for peace training, the combination of powder, guns, mounts, and projectile could be carefully studied and understood before hostilities. This might be done for the more important harbors at least.

The point has been well made that possibly it would be better to know by ordnance tests the mean velocity to be expected from a lot of powder, then to accept this and stick to it, and to express any deviation at long range by a varition in the ballistic coefficient, i.e., throw the deviation into atmosphere instead of into velocity. For the deviation of the center of impact, particulary at the longer ranges, say over

12,000 yards, may be due as much to a defective determination of the meteorological conditions as to a faulty assumption of velocity. A little work at the range board will show how at long range the difference between the directions of the velocity and atmosphere curves may throw the center of impact off the target, when adjusted at one range, if the target changes in range. That is, if the deviation at one range is thrown into velocity where it should have been thrown into atmosphere, the error introduced will be apparent on investigation as the target changes in range. This is one of the problems to be solved in long range work. The powder study may give some material assistance, particularly if the shots were fired at about 10,000 to 12,000 yards, and it may be especially valuable for night firing where the ranges are short and observation difficult, in which case it will probably be possible to make an *a priori* solution and stick to it. With a large *C* a given variation in velocity will cause a greater divergence in yards for a given range than it will for a small *C;* but the converse holds true with respect to *changes* in *C.*

The following information and data concerning two gunnery courses held during the months of May and August, 1915, respectively, by the 1st and 2nd sections of the regular class at the Coast Artillery School may be of interest to the service. The firings were similar as regards the number of rounds and the procedure. The general problem was as follows for each firing:

1. Make a powder study of the lot to be fired and determine the mean "velocity" developed heretofore. Call this "Velocity A."
2. Assume "Velocity A" and fire 3 trial shots at 10,000 yards to determine "Velocity B."
3. Using "Velocity B," fire 6 calibration shots at 10,000 yards.
4. Using "Velocity B," fire 6 calibration shots at 7000 yards.
5. Using "Velocity B," fire 6 calibration shots at 4000 yards.
6. Determine the mean "velocity" of the 6 calibration shots at 10,000 yards. Call this "Velocity C."
7. Determine the mean "velocity" of the 9 shots at 10,000 yards and call this "Velocity D."
8. Determine the range deviation of the center of impact from the aiming point at 10,000, 7000, and 4000 yards

due to using, at each range, "Velocities" A, B, C, and D, respectively.

9. Compute the probable error at each of these ranges.

10. For each of these ranges compute the curves showing how the probability of hitting would be affected by shifting the center of impact from the center of the target by increments of 40 yards up to 160 yards:—target, the *Centurion* (British dreadnought) Bow On and Broadside On. (For the solution see pages 74 and 75, and Charts C, page 51; D, page 53; E, page 55; and F, page 57).

Among the points of interest discernable in the results of these firings are the following:

a. While the term "Calibration" is applied to these firings, the purpose indicated could nor be satisfied by the firings because neither the angle of departure nor the muzzle velocity was measured for each shot. It is sufficient to note that in neither firing did either gun shoot materially differently from its companion. Nor if they had ranged differently would there have been justification for assuming that one gun would shoot farther than the other, because the accidental velocities developed were not measured and the other gun might have given the same results with the same charges.

b. That in Series I the powder study succeeded for the trial and calibration firing, but the study of the results of the latter was in error for "velocity" by −30 f.s. when it came to the record series.

c. That in Series II the powder study gave a "velocity" 30 f.s. too great as indicated by the trial and calibration firing, and it failed again, when based on the trial and calibration firing, by +20 f.s. for the record series.

d. That in Series I when the C.I. had been adjusted at 10,000 yards, it went to −53 during the calibration firing at 10,000 yards, then to +28 at 7000, and to +163 at 4000 yards; while in Series II the center of impact when adjusted by the trial shots staid sensibly correct at 10,000 yards, then fell to −59 at 7000, and rose to +30 at 4000 yards. Yet the only deviation which would have had any *material effect* on the *probability of hitting* would have been that at 4000 in Series I.

e. That the probable error at each range in Series II was only one-third of what it was in Series I.

f. That when the probable error undergoes such a reduction,

(1) The center of impact when adjusted by 3 or 4 trial shots may approximate closer to the mean of the group following because the individual shots of the total group may be expected to have such a greater degree of uniformity when firing single section core igniter charges;

(2) But due to the reduced probable error with single section core igniter charges, a given error in the adjustment of the center of impact will have a greater effect on the probability of hitting, causing a greater *loss* in probability.

g. The failure of the center of impact to remain adjusted from range to range and from day to day indicates a degree of failure of our correction devices from day to day and from range to range.

e. In the light of its *effect on the probability of hitting* these practices indicate that whenever there is a change in the reference numbers between the firing of trial shots and the commencement of the firing at a target, a further adjustment of the center of impact may be necessary.

f. That increasing *accuracy of fire* demands increasing *accuracy of practice.* Note that when the centers of impact are adjusted to the center of the target the probability of hitting (by Chart D, target Broadside) is 35% with the single section core igniter charge at 10,000 yards and is only 12% with the double section charge; but when the gun is laid in error for any cause by 160 yards, the probability with the single section core igniter charge has no advantage over the other, and will be less for somewhat greater errors.

g. That with errors such as exhibited in Series I, intelligent correction of fire is exceedingly difficult, but with such accuracy of fire as shown in Series II the problem may be somewhat simplified due to the fact that a fewer number of shots will serve to indicate the position of the center of impact with reference to the range for which the guns were expected to have been laid on information from the plotting

SERIES I

TARGET PRACTICE DATA—TRIAL AND CALIBRATION FIRING

STUDENT OFFICERS, MAY 20, 1915. BATTERY CHURCH: 2 10-in. Model 1895 on D.C.L.F. Number of times previously fired: No. 1, 27; No. 2, 29.

Powder: Picatinny Blend "E," in two sections, not blended at battery. Adjusted by Ord. Dept. for 2265 f.s. in this model of gun.

	TRIAL			CALIBRATION																	
Shot No.	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Gun No.	1	1	1	1	1	1	2	2	2	1	1	1	2	2	2	2	2	2	1	1	1
Wind Ref. No.	34			34																	
Temp. of Powder	61			61																	
Atmosphere	15			15.2																	
RANGES AS PLOTTED (Agreement sufficiently close to ranges as computed from B′, B″, and B.C. data.)																					
B.C. to Splash	10,233	9,850	9,925	10,205	10,060	9,850	10,150	9,790	9,630	6,870	7,075	6,970	7,080	7,110	7,060	4,300	4,210	3,900	4,155	4,210	4,205
Vel. by Vel. Graphic Chart	2294	2223	2238	2284	2260	2223	2275	2214	2185	2222	2265	2242	2265	2273	2262	2346	2315	2215	2295	2316	2315
Pressure	36,038	37,279	37,260	34,933	36,550	36,113	34,708	36,550	35,615	36,720	37,218	36,452	36,965	37,400	37,572	38,585	37,468	32,872	37,652	36,965	38,235
Mean Velocity, 2263																					
Velocity Error	31	40	25	21	3	40	12	49	78	41	2	21	2	10	1	83	52	48	32	53	52
Mean Velocity Error, 33																					
Mean Vel., No. 1 Gun	2265	2265	2265	2265	2265	2265				2265	2265	2265							2265	2265	2265
Mean Vel. Error, No. 1 Gun	30	30	30	30	30	30				30	30	30							30	30	30
Mean Vel., No. 2 Gun							2261	2261	2261				2261	2261	2261	2261	2261	2261			
Mean Vel. Error, No. 2 Gun							38	38	38				38	38	38	38	38	38			
Velocity "A," 2250																					
Velocity "B," 2250																					
Velocity "C," 2240																					
Velocity "D," 2244																					

Range	10,000									7,000						4,000					
Deviation of C.I. "Vel. A"	+ 3	+ 3	+ 3	−53	−53	−53	−53	−53	−53	+28	+28	+28	+28	+28	+28	+163	+163	+163	+163	+163	+163
Deviation of C I. "Vel. B"	+ 3	+ 3	+ 3	−53	−53	−53	−53	−53	−53	+28	+28	+28	+28	+28	+28	+163	+163	+163	+163	+163	+163
Deviation of C.I. had "Vel. C" been used	+70	+70	+70	+15	+15	+15	+15	+15	+15	+88	+88	+88	+88	+88	+88	+203	+203	+203	+203	+203	+203
Deviation of C.I. had "Vel. D" been used	+43	+43	+43	−13	−13	−13	−13	−13	−13	+66	+66	+66	+66	+66	+66	+183	+183	+183	+183	+183	+183

VELOCITIES COMPENSATED FOR *MEAN EXPECTED* JUMP

Mean V, 2271	2297	2234	2246	2293	2269	2234	2284	2223	2195	2230	2272	2250	2273	2280	2269	2353	2323	2219	2305	2323	2322

RECORD SHOTS (V used was 2250)
(May 21, 1915)

Shot No.	1	2	3	4	5	6
Gun No.	2	1	1	2	1	2
Range to Target	8,495	7,845	7,710	8,800	8,695	8,650
Armament Error	+255	+170	+54	+110	+326	+18
Deviation of C.I.	+155	......	......	......	......	......
Vel. by Vel. Graphic Chart	2300	2283	2262	2271	2313	2253
Mean Velocity	2280	......	......	......	......	......
Max. Pressure, No. 1	38,060	......	......	......	......	......
Max. Pressure, No. 2	38,230	......	......	......	......	......
Wind Ref. No.	43	44	44	42	42	42
Atmosphere	17.8	......	......	......	......	......
Temp. of Powder	63	......	......	......	......	......

PROBABILITY OF HITTING *CENTURION* TARGET*
(Data for Solution)

Range	Slope of Fall (1 on –)	Target, Broadside	Target, Head On	Probable Error
10,000	1 on 4.4	93	130	210
7,000	1 on 8.5	160	183	160
4,000	1 on 18.5	330	230	100

* Target "Head On" taken from waterline opposite front of forward barbette to the point on the water astern which a shot (with the angle of fall for the range) would strike if it pierced a point half way up the rear edge of the barbette of the fourth turret. This allows for the reduced deck area at the ends and for the narrowness of the turrets themselves.

SERIES II

TARGET PRACTICE DATA—TRIAL AND CALIBRATION FIRING

STUDENT OFFICERS, AUGUST 26, 1915. BATTERY EUSTIS: 2 10-in. Model 1888 MII on D.C.L.F. Number of times previously fired: No. 1, 113; No. 2, 157.

Powder: Picatinny Blend "E," in single sections with core igniter, blended at battery. Adjusted by Ord. Dept. for 2250 f.s. in this model of gun.

	TRIAL			CALIBRATION																	
Shot No.	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Gun No.	1	1	1	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Wind Ref. No.	46			43						44											
Temp. of Powder	76.5																				
Atmosphere	17.8			19						19.7						19.5					
(Range)																					
B.C. to Splash	10,020	9,720	9,745	10,000	9,895	9,960	10,025	10,040	10,160	6,875	6,905	6,990	7,030	6,860	6,985	4,025	3,980	3,970	4,030	4,095	4,080
Vel. by Vel. Graphic Chart	2212	2162	2167	2180	2161	2172	2182	2185	2205	2155	2162	2179	2184	2152	2177	2188	2174	2170	2190	2210	2205
Pressure	33,436	33,879	33,436	33,671	32,690	33,752	33,994	34,994	34,673	33,837	33,839	33,596	33,508	32,935	34,538	33,806	32,800	33,515	32,000	34,385	33,039
Mean Velocity, 2180																					
Velocity Error	32	18	13	0	19	8	2	5	25	25	18	1	4	28	3	8	6	10	10	30	25
Mean Velocity Error, 14																					
Mean Velocity, No. 1 Gun	2178																				
Mean Vel. Error, No. 1 Gun	15																				
Mean Velocity, No. 2 Gun	2182																				
Mean Vel. Error No. 2 Gun	12																				
"Velocity A," 2210																					
"Velocity B," 2180																					
"Velocity C," 2181																					
"Velocity D," 2181																					

Range	T = 10,000			10,000						7,000						4,000					
Deviation of C.I.	−172	−172	−172	+13	+13	+13	+13	+13	+13	−59	−59	−59	−59	−59	−59	+30	+30	+30	+30	+30	+30
Deviation of C.I. had "Vel. A" been used	−172	−172	−172	−159	−159	−159	−159	−159	−159	−209	−209	−209	−209	−209	−209	−60	−60	−60	−60	−60	−60
Dev. of C.I., "Vel. B"	0	0	0	+13	+13	+13	+13	+13	+13	−59	−59	−59	−59	−59	−59	+30	+30	+30	+30	+30	+30
Deviation of C.I. had "Vel. C" been used	0	0	0	+13	+13	+13	+13	+13	+13	−59	−59	−59	−59	−59	−59	+30	+30	+30	+30	+30	+30
Deviation of C.I. had "Vel. D" been used	0	0	0	+13	+13	+13	+13	+13	+13	−59	−59	−59	−59	−59	−59	+30	+30	+30	+30	+30	+30

RECORD SHOTS (V used was 2180)
(August 27, 1915)

Shot No.	1	2	3	4	5	6
Gun No.	1	2	1	2	1	2
Range to Target	8,890	8,820	8,800	8,745	8,715	8,680
Armament Error	−100	−175	−77	−141	−172	−40
Deviation of C.I.	−117	......	......	......	......	......
Vel. by Vel. Graphic Chart	2,161	2,150	2,167	2,153	2,151	2,172
Mean Velocity	2,159	......	......	......	......	......
Max. Pressure, No. 1	33,113	......	......	......	......	......
Max. Pressure, No. 2	34,077	......	......	......	......	......
Wind Ref. No.	39	......	40	......	......	......
Atmosphere	17.5	......	......	......	......	......
Temp. of Powder	76.5	......	......	......	......	......

PROBABILITY OF HITTING *CENTURION* TARGET*
(Data for Solution)

Range	Slope of Fall (1 on −)	Target, Broadside	Target, Head On	Probable Error
10,000	1 on 4.4	93	130	72
7,000	1 on 8.5	160	183	52
4,000	1 on 18.5	330	230	32

* Target "Head On" taken from waterline opposite front of forward barbette to the point on the water astern which a shot (with the angle of fall for the range) would strike if it pierced a point half way up the rear edge of the barbette of the fourth turret. This allows for the reduced deck area at the ends and for the narrowness of the turrets themselves.

SERIES I

Probable Error = 100 — 4,000 Yards

	Broadside On										Head On									
(a) Deviation of C.I.	0		+40		+80		+120		+160		0		+40		+80		+120		+160	
(b) Permissible Error	+165	−165	+125	−205	+85	−245	+45	−285	+5	−325	+115	−115	+75	−155	+35	−195	−5	−235	−45	−275
$Z/Z_1=(b)/100$	1.65	1.65	1.25	2.05	.85	2.45	.45	2.85	.05	3.25	1.15	1.15	.75	1.55	.35	1.95	.05	2.35	.45	2.75
$P/2=$	36.5	36.5	30	42	22	45	12	47	1	49	28	28	19	35	9	41	1	44	12	47
%Probability	73		72		67		59		50		56		54		50		43		35	

Probable Error = 160 — 7,000 Yards

(b) Permissible Error	+80	−80	+40	−120	0	−160	−40	−200	−80	−240	+92	−92	+52	−132	+12	−172	−28	−212	−68	−252
$Z/Z_1=(b)/160$	.50	.50	.25	.75	0	1.00	.25	1.25	.50	1.50	.63	.63	.33	.82	.08	1.07	.18	1.33	.43	1.58
$P/2=$	13.5	13.5	7	19	0	25	7	30	14	34	16.5	16.5	9	21	2	26	5	32	12	36
% Probability	27		26		25		23		20		33		30		28		27		24	

Probable Error = 210 — 10,000 Yards

(b) Permissible Error	+47	−47	+7	−87	−33	−127	−73	−167	−113	−207	+65	−65	+25	−105	−15	−145	−55	−185	−95	−225
$Z/Z_1=(b)/210$	.22	.22	.03	.41	.16	.60	.35	.80	.54	.99	.31	.31	.12	.50	.07	.69	.26	.88	.45	1.07
$P/2=$	6	6	1	11	4	16	9	20	14	25	8	8	3	13	2	18	7	22	12	27
% Probability	12		12		12		11		11		16		16		16		15		15	

SERIES II

Probable Error = 32 — 4,000 Yards

	Broadside On										Head On									
(a) Deviation of C.I.	0		+40		+80		+120		+160		0		+40		+80		+120		+160	
(b) Permissible Error	+165	−165	+125	−205	+85	−245	+45	−285	+5	−325	+115	−115	+75	−155	+35	−195	−5	−235	−45	−275
Z/Z_1 = (b)/32	5.16	5.16	3.90	6.41	2.66	7.66	1.40	8.91	.16	10.2	3.59	3.59	2.35	4.84	1.09	6.10	.16	7.35	1.40	8.60
$P/2$ =	50	50	50	50	47	50	33	50	4	50	49	49	44	50	27	50	4	50	33	50
%Probability	100		100		97		83		54		98		94		77		46		17	

Probable Error = 52 — 7,000 Yards

(b) Permissible Error	+80	−80	+40	−120	0	−160	−40	−200	−80	−240	+92	−92	+52	−132	+12	−172	−28	−212	−68	−252
Z/Z_1 = (b)/52	1.54	1.54	.77	2.31	0	3.08	.77	3.85	1.5	44.62	1.77	1.77	1.00	2.54	.23	3.31	.54	4.08	1.31	4.84
$P/2$ =	35	35	20	44	0	48	20	50	35	50	38.5	38.5	25	46	6	49	15	50	31	50
% Probability	70		64		48		30		15		77		71		55		35		19	

Probable Error = 72 — 10,000 Yards

(b) Permissible Error	+47	−47	+7	−87	−33	−127	−73	−167	−113	−207	+65	−65	+25	−105	−15	−145	−55	−185	−95	−225
Z/Z_1 = (b)/72	.65	.65	.08	1.21	.46	1.76	1.01	2.32	1.57	2.87	.90	.90	.35	1.46	.21	2.02	.76	2.57	1.32	3.12
$P/2$ =	17	17	3	29	13	39	25	44	36	48	23	23	9	34	6	42	19	46	32	49
% Probability	34		32		26		19		12		46		43		36		27		17	

A FIRING SIGNAL VISUALIZER FOR MORTAR BATTERIES

By Electrician Sergeant LYNN P. VANE, C. A. C.

The use of firing signal bells in the drill for mortar batteries, while very simple in theory, is attended with many difficulties. One of the chief of these is found in the battery commander's frequent inability to remember which pit of his battery is ready to fire. When the pit officer signals "Ready," one of the bells in the battery commander's station rings; and, as the gongs of the two bells are varied in design to give entirely different sounds, it is easy for the battery commander to tell which pit has signalled: but, in the multiplicity of that officer's duties, his attention may be immediately distracted to some other phase of his work and, when the time comes for him to signal "Fire," he may easily and excusably push the button for the wrong pit. If he employs an enlisted man to keep some form of memorandum for him, as many officers do to avoid the other trouble, he is using a man who may be needed for other work, besides introducing another chance for personal error.

To overcome this difficulty, the firing signal visualizer has been devised. Models have been experimentally installed for Batteries Kearny and Chase, in the Coast Defenses of Portland, where they have proved to be efficient and helpful. The visualizer is simple in construction, installation, and operation, and is less likely than the bells to get out of order, especially on long lines.

The firing signal visualizer is used as follows: Two lamps, differentiated in color or markings, or merely in position, represent the two pits of the battery. When a pit signals "Ready to fire," its signal lamp lights and remains lit until the command "Fire" is given, when the light goes out. The bell signal is unchanged. The action is entirely automatic, and the light flashes on or off as surely as the bell rings. A glance at the lamps instantly shows the battery commander which pit is ready, and his memory is not taxed to any degree.

This action is obtained by the use of automatic electric relays, which open and close the lamp circuits when current is passed through the magnet coils. The circuit-closing magnets are wired in parallel with the bells in the station, and have a high resistance (500 ohms). The circuit-opening magnets are in series with the bells in the pits, and have a low resistance, or, better, have a high resistance which is shunted by a non-inductive coil so that the bells receive enough current for operation. A switch is provided for instant disconnection of the device.

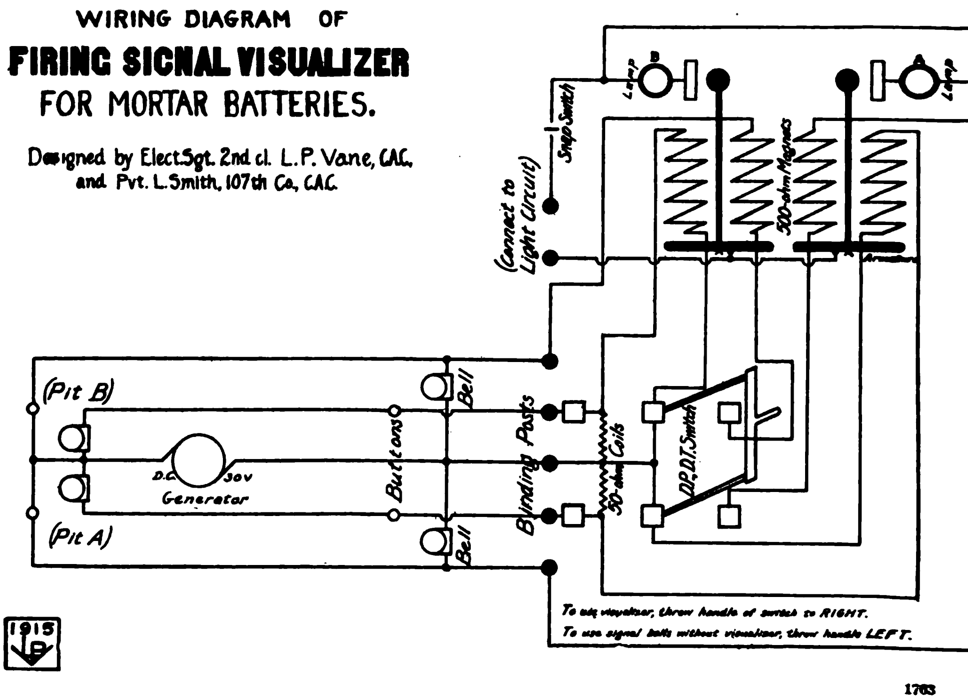
The visualizer is installed in any convenient place (the ceiling of the station is good), and is connected to the binding posts of the firing signal box by means of two headset cords or five well insulated wires. The lamp circuit is connected to the station lighting circuit, conveniently at the azimuth instrument fuse block.

The mechanical construction may be considerably varied, and may depend somewhat upon the materials easily obtainable. The moving parts and electrical connections may be exposed to view for ease in testing, inspection, or repair; or may be concealed for neatness in appearance and safety from tampering and dust. The original model will be partially described.

Two polarized ringers, 1000-ohm, of the type commonly used in telephones, supply the necessary four magnets and two double-acting armatures. Remove the gongs and the springs of the ringers, and cut the wire which connects the two magnets of each ringer. Connect the magnets to the posts of a double pole, double throw switch as shown in the diagram, being careful that the polarity of each electromagnet is the same as that of the permanent magnet which is a part of the ringer. Connect the armature rod (bell clapper) by means of a flexible wire to the frame of the ringer, to secure good electrical contact, and join the frame to one side of the lighting circuit. Mount the ringers, side by side, on the back of a small board, with the armature rods horizontal and passing through holes in the board. On the front of the board mount two lamp receptacles, candelabra size; connect one side of each, in parallel, through a switch, to the station lighting circuit, and the other sides to copper or brass contacts which will be just touched by the bell clapper in its outer position. The lamp circuit is now complete, and the device needs only to be electrically connected to the signal bell binding posts.

Binding posts on the back of the visualizer, where the switches also are mounted, will be a material aid in making and in changing connections. The permanent magnets must remain on the ringers, as they serve to hold the armatures in place after current has ceased to flow through the coils. Considerable shock is required to jar the armature from any position in which it is left.

A wiring diagram of the visualizer, including a theoretical diagram of the regular firing signal circuit as installed by



the Signal Corps, is shown herewith. Extensive tests have been made with different systems of wiring, and this system appears to be best in case of installation, non-interference with the Signal Corps lines, sureness of operation, and simplicity of repair. Various schemes tested have been: all magnets in parallel with bells; all magnets in series with bells and shunted; low resistance magnets, without shunts, in series with bells; circuit-opening magnets operating by current from independent or lighting circuit, with a change in the construction of the station push button.

The use of relays in the bell circuits, frequently installed

on long lines, will make no difference in the connections of the visualizer.

The lamps used are 110-volt, 2 c.p., frosted. They may be covered by a window of frosted glass, having on it the letters "A" and "B" to be illuminated by the light. A stiff wire soldered to each armature rod and passing to a position easily reached will provide a simple means of turning out the light when "Relay" is ordered by telephone. A more complex means is the winding of a few extra turns of wire around the circuit-opening magnets and connecting this wire through a push button and lamp to the lighting circuit. Pressure on the button will put out either light.

The non-inductive shunt which parallels the circuit-opening magnet will have a resistance of about 50 ohms. The best resistance for a given line will vary with the line resistance, and may easily be found by experiment. The resistance must be low enough to allow sufficient current to pass through the bell, and high enough to give plenty of current to the magnet.

A snap switch may be substituted for the D. P., D. T. switch shown in the diagram. Take an ordinary double pole snap switch, and change its design so that the blades will be parallel instead of perpendicular to each other and will be electrically connected to the central spindle of the switch; then use the center the same as the two middle posts of the knife switch, which are shown connected together in the diagram. Either type of switch provides a simple means of taking the visualizer out of the signal circuit if desired.

The materials for this device for one mortar battery will cost between four and five dollars in the local market.

NON-COMMISSIONED OFFICERS' SCHOOLS

By First Lieutenant WALTER J. BUTTGENBACH, C. A. C.

In the *Regulations for the Instruction and Target Practice of Coast Artillery Troops 1914* it is required that coast artillery organizations do certain infantry work as drill, marches, field exercises, patrolling, outpost, advance and rear guard, company in attack, defense, etc., etc. In paragraph 19 of said Regulations, it is stated in very *general* terms what should be covered in the instruction of non-commissioned officers.

It is to include:

a. Hygiene and care of person in the field.
b. Camping and camp sanitation.
c. The use of intrenching tools.
d. Individual and combined sketching in the field.
e. Map reading and road and position sketching.
f. Service of patrolling, advance, rear and flank guards and outposts.
g. Supply of troops in the field.

Besides there is required a knowledge of certain portions of the *Infantry Drill Regulations, Manual of the Bayonet, Field Service Regulations, Army Regulations, Small Arms Firing Regulations, Manual of Interior Guard Duty, Individual Cooking,* etc., etc., all of which can be made into rather an ambitious program of instruction.

While the *Coast Artillery Instruction Order, 1916* does not specify in detail the subjects to be taught non-commissioned officers, it does require for coast artillery troops "Infantry instruction, including the school of the soldier, of the squad, of the company, and, when practicable, of the battalion and of the regiment; marches; field exercises; intrenching; camping; small arms practice; and ceremonies." Consequently, instruction must be given in the sub-heads of paragraph 19 in the former instruction order.

In this paper it is only contemplated to refer in general

to what may be called our infantry problem that confronts us in the coast artillery, and more specifically to the training of our non-commissioned officers in this work. It is, of course, in no way intended to enter into the question as to the why's and wherefor of infantry work for coast artillery which is beyond our province, but only to attempt to get up a logical system of instruction for carrying out the infantry part of our Instruction Order, and this mainly through training our non-commissioned officers.

Under the present scheme we have only a bare outline of what is contemplated; but unfortunately, when we begin to attack this problem, we see that we have as many methods as we have various coast defense commands, or even as we have company commanders. It is a commentary on our military methods that, while we have been busy with officers' schools, service schools of the various arms, and schools for various classes of work, as for example, bakers, cooks, etc., etc., the non-commissioned officers' school has apparently never been standardized. It is a truism that we all accept, that the non-commissioned officers make the company, and I am willing to go further and say they make the regiment.

Progress in any scheme of instruction or in methods of training can never be satisfactory till we have a certain standardization. We accept this principle when it comes to our artillery work as is seen in the issuing of an annual order governing our artillery instruction and target practice, and our present day efficiency along those lines is manifest.

In other words, what *must* our non-commisssioned officers know in order to be more efficient and to properly do the work that regularly belongs to them—having in view their probable field of usefulness. It must be remembered that the average intelligence of the men in our companies is about the same, or, generally speaking, one company is very much like another. We all get our recruits from practically the same sources, and it is largely a factor of chance that sends one man or another to a company. The problem before us, then, is virtually the same one as far as we are concerned, irrespective of the company or fort we are considering.

Promotion to the grade of non-commissioned officer is practically by selection as far as corporals are concerned, and by seniority in the case of corporals to sergeants. The reason for the original selection, is sometimes hard to establish. Promotion of non-commissioned officers should be by selec-

tion—but should come from men qualified with a certain military knowledge. We require an eligibility qualification for rated positions in the coast artillery, so why not go one step further and require eligibility lists for the basis upon which to make our promotions to the grade of non-commissioned officers.

In the scheme proposed, there should be two eligibility lists: the first one for privates to be eligible for corporal, and the second for corporals to be eligible for sergeant. No one should be promoted to either grade unless he obtains his promotion through these eligibility qualifications. It is, of course, not contemplated that these qualifications be made on only theoretical knowledge, or by mere memorizing of portions of our regulations; but by principles therein being shown practically.

By this method it is thought we would gain some of the following advantages:

1. A uniformly instructed set of non-commissioned officers in the same grade, irrespective of the company we might happen to meet.

2. A system of promotion based on *some* standard of qualification.

3. A method of practically eliminating, automatically, those of our non-commissioned officers in the lower grade that were not willing to advance and qualify themselves for higher positions.

4. An incentive for non-commissioned officers' schools and with it a greater interest in the work.

As a preliminary, a soldier before he takes up this work should be required to have a proper knowledge of reading, writing, and arithmetic. This should at least mean a knowledge in reading equivalent to an ordinary Third Reader, the understanding of what is read; in writing, one of simple legibility and clear expression of what one desires to say; and in arithmetic up to and including fractions and simple proportion. This ground work, if the man has it not, the post school should give him, or he should get it by private study. It is utterly absurd to attempt later on, not only the making of maps, or even reading them, where the man himself cannot even comprehend the basic ideas underlying measurement as in the use of scales. On the other hand, he should be able to handle his own language sufficiently so as to be able

to write a short message such as should be expected from a patrol leader.

Having reached this point, the next question is to consider the formation of our first class—that of privates to obtain an eligibility rating for corporal.

Class for Privates

Allow any man in the company to attend who desires to; next detail a percentage of men who show they have the material in them to make non-commissioned officers; have the sergeants and corporals recommend others. It will probably be found that few men will volunteer for school, and probably those that are the most promising will need encouragement to take up this work.

The course outlined will have to be made elemental and should include portions of the *Infantry Drill Regulations, Manual of Interior Guard Duty, Small Arms Firing Regulations,* and also to include First Aid Instruction, Personal Hygiene, Elements of Map Reading and Writing of Patrol Messages.

A suggested syllabus is shown in Appendix "A."*

This course does not make any undue demand and will give us an opportunity to find which of our men show keenness, and further assist in the selection of non-commissioned officers.

The men, of course, should be given an opportunity to do things practically, and this work should not degenerate into merely reciting from a series of books.

At the completion of the course, have an examination, and to those passing give certificates of eligibility signed by the company commanders. Also, note this eligibility on the soldier's descriptive list as well as on his discharge.

The next step would be the class of corporals for eligibility rating for sergeant.

Class for Corporals

This course will require the holding of the certificate of the previous course, and all corporals of the company should

* In this connection, would it not be practicable to have published in the same way as our *Gunners' Instruction*, special instruction manuals covering these courses; say one for course "A," another for course "B," or one including both which would include the entire courses having extracted such part of our manuals and standard text-books as required—and these be sold at a nominal price?

There are several books published which practically cover these subjects, but their price is prohibitive, considering that most non-commissioned officers should have them.

be required to take it. There will be studied additional portions of the *Infantry Drill Regulations*, and the Manuals already noted, and, in addition, certain portions of the *Field Service Regulations*, map making, elemental map problems, etc. A suggested syllabus is given in Appendix "B."

Have an examination at the end of the course and authorize certificates in same way as in first course.

Thus appoint no man a corporal who has not the certificate of the first course, and no man a sergeant who has not that of the second. If a corporal fails to hold the certificate for sergeant, simply pass him over in promotion and do not reenlist him in his grade.

Class for Sergeants

For the sergeants,* i.e., those holding certificates of eligibility for both grades, as herein outlined, provide a class taking up subjects required for volunteer commissions as outlined in G. O. 54, W. D., July 8, 1914, and, on completion of the course, on recommendation of their company and higher commanders, let them—if the non-commissioned officer makes application therefor—take the examination for a commission in the volunteers.

The attendance of this class should be voluntary. If a sergeant has passed the examination for a volunteer commission, have some distinguishing mark on his uniform similar to that which is authorized for enlisted men obtaining certificates of eligibility for appointment as second lieutenant; and, furthermore, if legislation could be obtained, give them an increase of pay, say ten dollars a month and limiting them to a certain number in a company, say three or four.

Remarks

In this plan so far outlined, have sergeants as instructors in the first class, the company officers in the second class, and officers designated by the Fort Commander for the third class.

These classes should be held three times a week during the indoor season for the theoretical portions, and the first

* In view of the fact that at present we have no definite plan, require the present sergeants to take the examination covered by subjects in syllabus B and the corporals that in syllabus A. Those that do not pass at present, give them an opportunity to take up these courses at the first regular opportunity and then establish the matter of their eligibility. Those that fail to pass, then, should be reduced.

month of the open season should be devoted to practical infantry work if weather conditions permit. These schools to be in session at regular times and to be considered of sufficient importance to have no duty except one of urgent necessity interfere. It is useless and only a waste of time to have a scheme of instruction if one-half of the classes enrolled miss one-half of the instruction—no progress is possible under such conditions.

It is, of course, admitted that the scheme herein proposed is perhaps not the ideal one, nor is the program as outlined perhaps what others would have it; but it is a beginning.

With the problems ahead of us, and the chances in store for us to be made use of as infantry, we must be prepared. With the prospects of a shorter enlistment period, our training methods must be radically changed—they must become intensive. Our army is largely a school, and with a shorter enlistment it must become more so. We must establish a different table of values and remember that it is the *war value* of our organizations that will count on the firing line and not necessarily some of our garrison standards.

Besides, we are training our non-commissioned officers along the lines they should be qualified, helping our men to be fit for higher responsibilities in war, and opening the way for our more zealous ones to obtain volunteer commissions.

The Regular Army, due to inherent political ideals of our people, will probably always be small in proportion to our population, thus accentuating the school side of our service, and to what better use can we bend our energies than training some of our men to help in turn to train the volunteer troops—who will largely compose our armies in time of war.

APPENDIX "A"

Infantry Drill Regulations.—

Definitions:	Pages 7-8.
Part I:	Drill.
	School of the Soldier, Etc., pages 9-32.
	School of the Squad, pages 32-44.
Part II:	Combat.
	Introduction, pages 91-93, pars. 350-357.
	Leadership, pages 93-95, pars. 358-370.
	Teamwork, pages 95-96, pars. 371-377.
	Fire Superiority, pages 100-105, pars. 400-424.

Intrenchments, pages 131-135, pars. 584-595. (Use of, example of, making models of trenches and the actual trenches.)

Patrols, pages 137-140, pars. 604-622. (Various classes of, patrol messages, patrol by map.)

Part III: Marches and Camp.

Marches, pages 141-148, pars. 623-660.

Camps, pages 148-158, pars. 661-707.

Part IV: Inspections.

Company Inspection, pages 171-173, pars. 745-748.

Honors and Salutes: pages 176-177, pars. 758-765.

Manual of Tent Pitching: pages 187-191, pars. 792-803. (Rolling of blankets, packs, loading wagons, care of equipment.)

Manual of the Bayonet.—

Manual of Interior Guard Duty 1914.—

Corporal of the Guard: pages 25-31, pars. 104-137.

Musician of the Guard, Orderlies, Etc.: Pages 31-33, pars. 138-153.

Privates of the Guard: pages 33-52, pars. 154-256; pages 61-65, pars. 299-307.

Small Arms Firing Regulations.—

Sighting Drills: Chap. I, pages 25-35.

Position and Aiming Drills: Chap. II, pages 35-47.

Deflection and Elevation Correction Drill: Chap. III, pages 47-51.

Gallery Practice: Chap. IV, pages 51-52.

Nomenclature and Care of Rifle.

First Aid Instruction and Personal Hygiene.—

The ground covered by some recognized instruction manual such as the *Red Cross Manual* or Johnson's *First Aid Manual*, as may be considered necessary.

Personal Hygiene.—

Selected portions of Ashburn's *Elements of Military Hygiene*, Chaps. I, II, IV.

G. O. 26, W. D. 1912, Care of Feet.

Elements of Map Reading.—

Use of Maps.

Different Kind of Maps.

Scales and How Indicated.

Conventional Signs, use of.

Contours, meaning of.

Earth Forms Shown on Sand Table.
Identifying Your Position on a Map.
How to Carry a Map.

Writing of Patrol Messages.—

Such as would ordinarily occur in the field as when conducting a small patrol. Forms, usual terms used, etc.

Army Regulations.—

Rank: pars. 1-20.
Company Administration: pars. 265-302.
Honors: pars. 375-392.
Rations: pars. 1202-1214. (Individual Cooking.)
Clothing, (how obtained).
Pay and Allowances.
Articles of War.

APPENDIX "B"

Infantry Drill Regulations.—

Part I: School of the Company, pages 45-66.
School of the Battalion, pages 67-71 (including duties of guides and of non-commissioned officers in command of companies) pars. 258-271.

Part II: Combat.
Deployment, pages 105-108, pars. 425-441.
Attack, pages 108-114, pars. 442-480.
Defense, pages 115-118, pars. 489-510.
Night Operations, pages 125-129, pars. 558-568.

Manual of Interior Guard Duty.—

Introduction: pages 7-12, pars. 1-26.
Commander of Guard: pages 14-20, pars. 41-79.
Sergeant of the Guard: pages 21-25, pars. 80-103.
Prisoners, Etc.: pages 52-65, pars. 257-307.
Flags, Etc.: pages 70-82, pars. 337-367.

Field Service Regulations.—

Organization: pages 9-11, pars. 1-8.
Patrols: pages 17-19, pars. 23-29.
Security: pages 24-40, pars. 37-83.
Marches: pages 47-55, pars. 96-106.
Appendix 6: pages 190-196.

Laws of Land Warfare.—

Selected portions supplementing *Field Service Regulations.*

Organization Tables.—

Company, Battalion, and Regiment.

Small Arms Firing Regulations.—

Definitions, Etc.: pages 9-18.
Chap. V, Estimating Distances: pages 53-57.
Chap. VIII, Advice to Riflemen: pages 78-84.
Chap. IX, Pistol Practice: pages 84-91.
Chap. XI, Dismounted Course: pages 100-103.
Part III, Chaps. I, II, III: pages 117-142.
Lectures on:

Effect of Fire.
Influence of Ground.
Adjustment of Fire.
Scheme for Combat Practice.

First Aid Instruction and Personal Hygiene.—

Review of First Aid Instruction and selected portions of Ashburn's *Military Hygiene*, Chaps. III, V, VI, VII; supplemented by lectures by Post Surgeon.

Map Reading and Map Making.—

Construction of Scales.
Use of Sketching Board.
Use of Cavalry Sketching Board.
Traverse of Road.
Traverse of Closed Area and System of Checks showing Accuracy.
Typical Contour Forms.
Topographical Symbols, (different methods in use).
Visibility Problem.
Military Map Reading, Sherrill.
Military Topography, Sherrill (to include making of road and position sketches by simple methods).
Elemental Map Problems (placing troops on map, etc., etc.). (Ref.: Hanna's *Tactical Principles and Problems.*)

A SUGGESTED LIST OF BOOKS

Infantry Drill Regulations.
Rules of Land War Fare.
Army Regulations.
Manual of the Bayonet.
Small Arms Firing Regulations.
Field Service Regulations.
First Aid Manual, Johnson.
Abridged Text Book of First Aid, Red Cross.

Military Hygiene, Ashburn.
Military Maps Explained, Eames.
Military Topography, Sherrill.
Tactical Principles and Problems, Hanna.
Manual of Military Training, Moss. (Contains practically in one book what may be used as the basis of the course herein outlined.)
Infantry Training, Morrison.

ANGULAR TRAVEL REFERENCE NUMBER COMPUTOR

By First Lieutenant ROY R. LYON, Coast Artillery Corps

The need for some device, separate from the plotting board, for the purpose of determining quickly and accurately by mechanical means the angular travel reference number, became apparent to many persons upon the adoption of plotting the set-forward point by gun plotting systems.

The idea of a separate device to determine the angular travel from azimuth readings taken on the D. P. F. was impressed upon the writer during the early part of the outdoor season of 1914, when it became necessary for the battery commander to work out a scheme of fire control for the 5-inch battery at Fort Terry, N. Y. In this case the plotting room is adjacent to the B. C. station, and the combined station is located at the battery; a vertical base is used.

Lieutenant Fred M. Green, C. A. C., covered many of the advantages of a separate device for the purpose of obtaining the angular travel of the target directly from the azimuths as read from an instrument at or near the battery, in an article which appeared in the JOURNAL for March-April, 1915. He uses a slide rule device for the purpose of obtaining his angular travel reference number.

It is the purpose of this article to describe a device which it is believed has some advantageous features which can not be obtained with a straight slide rule.

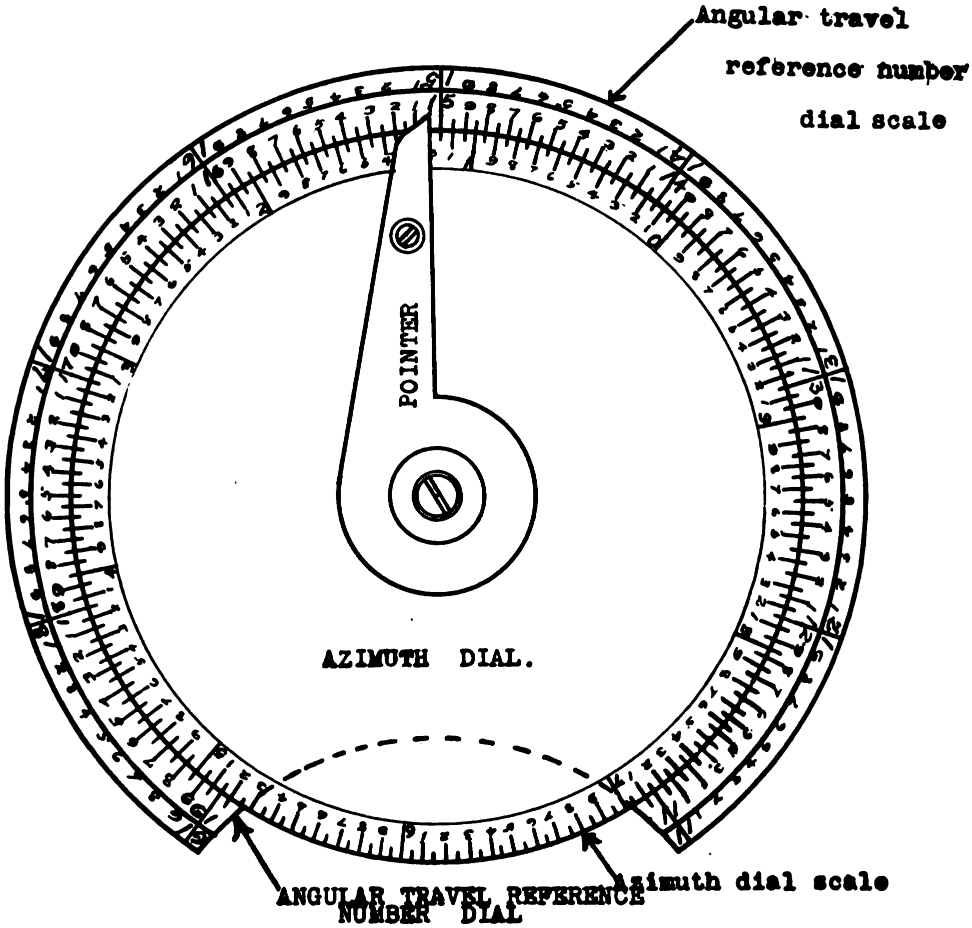
In the present case the rule is made circular. This gives a continuous scale. This circular scale also carries a pointer which holds the setting from one reading to the next.

It is believed that some of the advantages of the circular rule over the straight slide rule are:

1. It is not necessary to set off each azimuth reading more than once to obtain each angular travel reference number in any continuous operation.

2. It has one less scale, and is more compact and simple in operation.

3. It provides less chance for error.
4. Both the operator of this computor and the operator of the deflection board can easily read the angular travel reference number, thus making a check against error.



ANGULAR TRAVEL REFERENCE NUMBER COMPUTOR 1764

DESCRIPTION

The angular travel reference number computor consists of three moving parts secured at the center with a screw which may be adjusted to secure proper working of the parts. The instrument used in the present instance was constructed out of thin hard cardboard, with the scales drawn on with drawing ink. A better construction would be of celluloid with the scales cut.

The parts are the pointer, the azimuth dial and scale, and the angular travel reference number dial and scale.

The pointer is secured above the azimuth dial scale and may be set to any azimuth reading. When the azimuth dial scale is turned it carries the pointer, with the azimuth reading as set, to any other point on the angular travel reference number dial. In the operation the azimuth dial scale is turned back each time until the pointer indicates 15 which is the normal of the reference number dial.

The azimuth scale dial is divided into ten sectors numbered from 0 to 9. Each of the sectors is divided into ten parts with half divisions. These half divisions may be interpolated into five parts by eye, give readings to one one-hundredth of a degree.

The angular travel reference number dial is divided into divisions of the same angular value but are numbered from 11 to 19 with 15 at the center or normal of the scale. Two sets of numberings are placed on this scale so that it may be easily read from either side, as by the computor operator and the deflection board operator.

A convenient size for the azimuth dial is five inches in diameter. The reference number dial will then be about one inch larger. The screw at the center should be secured with a lock-nut so that when the tension has been regulated to permit the parts to function properly, the adjustment may be held secure.

Operation

When the first azimuth is received, the pointer is set to the units and hundredths on the azimuth dial scale. The azimuth dial is then turned so as to carry the pointer to 15.

When the second azimuth is received, the two dials are held between the fingers and the pointer is set to the new azimuth on the azimuth dial scale.

The pointer now indicates on the angular travel reference number scale the proper angular travel reference number.

After this data has been read off, the azimuth dial is turned so as to carry the pointer back to the normal (15) and the operator is ready for a new reading, when the cycle is repeated.

This device is accurate and gave satisfaction during target practice in 1914.

JOURNAL UNITED STATES ARTILLERY
PRIZE ESSAY COMPETITION
1916

The Journal U. S. Artillery announces the following for its annual competition.

PRIZES

One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the Journal.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the Journal of the United States Artillery. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the Journal and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

(f) Copy must be received on, or before, December 31st, 1916. It must be addressed Journal U. S. Artillery and the envelope must bear the notation, "Essay Competition."

NOTICES

The Journal U. S. Artillery desires to receive from its readers, titles of subjects which they consider would be of interest to the service.

The Library of the Coast Artillery School is prepared to accept books or collections of books, either as loan or gift. The building is fire proof and the best of care will be accorded any works entrusted to the Library.

It will be glad to have any copies of the Journal of the United States Artillery, or any copies of Artillery Notes, which their possessors do not desire to keep.

PROFESSIONAL NOTES

OUR BAPTISM OF FIRE

By Major A. SEEGER, Comdg. the Horse Artillery Abteilung of the 15th Regiment, German Artillery

Translated from *Art. Monatshefte*, June, 1915, by Brig.-Gen. H. A. BETHELL

Within a few days after mobilization, our Cavalry Division had assembled at Saarburg, and was impatiently awaiting the order to march on the enemy. Until the last of the transport units had arrived, my Abteilung (3 Horse Artillery batteries of 4 guns) was detailed as part of the main reserve guarding the frontier from the Vosges to the zone of our neighboring corps at Metz. We were prepared to march at a moment's notice, in case the French, as was generally expected, should attempt a strong offensive movement against our comparatively weak frontier guard. This guard had taken over charge of the frontier as soon as the prospect of war became threatening.

The French made no offensive movement, and we were accordingly able to carry out our mobilization unmolested. As early as the second day of mobilization, we were rejoiced by the arrival by rail of the first Bavarian troops from Augsburg and Lindau. These troops were joyously welcomed by the populace, who were beginning to fear for their own safety. For it was obvious to everybody that here, so close to the frontier, there was sure to be fighting before long. And the events of the 17th to the 20th August showed that this fear was only too well justified, as the ruined houses and barracks, mementoes of the bloody battle of the 20th August, bear witness to this day. Our Bavarians did not halt but marched on to their positions on the frontier, in order to relieve the troops of the Saarburg garrison, who had to join their division. Under the protection of the Bavarian Lion, everyone, civilians and soldiers, quietly and confidently awaited events.

When we heard of the storming of Liège and the brilliant early successes of our troops, we longed for the day when we should join in with our guns.

Our mobilization had proceeded exactly according to the regulations; before the end of the prescribed period, the last man, horse, and round of ammunition had arrived, and all was ready to march.

On the 8th of August, at noon, the alarm sounded, and we were ordered to march. In half an hour the Abteilung was harnessed up and hooked in, and we moved to our position of assembly at Heming. Our Uhlan patrols had already reported, on the previous day, that strong bodies of enemy cavalry with guns and cyclists were moving towards the district south of Lunéville; these were probably the local cavalry division with

troops from Toul. Some prisoners were brought in: these were cavalry patrols which our Uhlans, as in 1870, had chased and captured. These were cavalrymen from the South of France, who had been hurriedly railed to their destination with their full peace equipment.

In the blazing noonday heat we started on our march via St. George and Foulerey to the frontier, which we crossed with loud cheers. Near the frontier, on Hill 351, we halted, deployed, and took up a position; our reconnoitring squadrons had already advanced far into the country by Blamont, Domevre, and Verdenal without meeting an enemy. On our left were the Bavarians, fighting round Blamont, which place they occupied the same evening. Already, on the first day, the population had shown signs of hostility, and their behavior was afterwards visited with a terrible punishment both in Blamont and in the neighboring villages, where they had treacherously fired on our troops.

A little further on we went into bivouac, our first bivouac in the enemy's country, under a clear starlit sky. Next morning we started early on our march into the unknown. Once more we took up a position, awaited news of the enemy, and searched the country with our excellent "scissors" telescopes.* In the distance, some 7000 yards off, dense clouds of dust began to appear at Gondrexon, Reillon, and Chazelles, behind the widely-extending wood of Grand-Seille. We gradually made out these to be enemy cavalry on the move, but too far off to shoot at. Faithful to our rule, not to open fire at such distances, I refused to allow my battery commanders to fire and so reveal our presence.

At last, at 3 P. M., orders came to advance with our Bavarian cyclists and Rifles through Autrepierre on Gondrexon. In the latter place bodies of cavalry of considerable strength, and in rapid movement, were again visible; I came into action close above Autrepierre, in order to support our Rifles from this commanding position. The Abteilung came into action as smartly as in peace time; suitable observing positions were selected, telephone cables laid, and zones allotted. We saw nothing of the enemy's artillery; in fact, later on, this was almost always so. Then, suddenly, a squadron trotting, in a thick cloud of dust, appeared at Reillon; it was still over 5500 yards distant when I ordered one battery to open fire on it by "surprise," and our first shots rang out over the summer landscape. The bursts were a trifle short, but the effect was remarkably good; the enemy checked, evidently astonished by his first greeting from the German guns; then he wheeled about towards the hills, to get over and behind them, followed by our rapid fire, which caused him visible losses. He soon disappeared at full gallop. There was no other target in sight worth taking on.

We next advanced through Autrepierre village, which our Rifles had already siezed, to Gondrexon, with the cavalry and squadrons leading. Our patrols reported the enemy moving off to the south, so on again to Chazelles, where we waited for news. This advance at a smart pace on a blazing hot day had distressed our horses a good deal, and they were all of a lather. At Chazelles our patrols came galloping in to report: "Strong bodies of enemy cavalry with cyclists and artillery in front of us, on the road between Frémenil and Ogévillers." I immediately rode to our Divisional Commander and asked leave to come into action on Hill 297, S. W.

* This is a binocular telescope on a stand; it has arms which can be extended or erected to see over a crest.—*Tr.*

of Chazelles, about a mile to the front, in order to engage this target which seemed a very favorable one, as soon as possible.

Before I rode off I noticed for the first time, the outline of Fort Manonviller, plainly visible about 9000 yards off. So I pointed out to the Staff that it was not impossible that we might come under fire of the heavy guns of the fort, especially as the French postal telephones were not yet destroyed. There was a short discussion with the General Staff officer, who stated that the guns in question did not range more than 6600 yards—an opinion in which I did not concur—and off I galloped to the hill, sending word to the batteries to follow me as hard as they could lay legs to the ground. In the meantime our cavalry patrols in front had dismounted, and were exchanging shots with the enemy's Chasseurs in St. Martin at about 1650 yards. Our patrols soon retired, partly to make room for my guns, which were galloping up in battery column. When I reached the top of the hill, I saw before me a target for a gunner to dream of, such as we never get at practice or maneuvers. Some 4000 yards off was the high road from Frémenil to Ogévillers, covered with cyclists in half sections riding slowly; beyond the road were guns halted in a field; at the village strong bodies of cavalry were forming up, and the nearer village of St. Martin was occupied by French riflemen, who began to fire more rapidly as our patrols retired, and when they perceived me and my staff. A rapid glance at the situation decided me to come straight into action in the open, in order not to lose a second. I galloped along the position and picked out approximate battery positions, two on the right and one behind a sheepfold on the left. The batteries were to come into "action right" in order of their arrival.

As the battery commanders, who were not far ahead of their guns, galloped up to me, the enemy's rifle fire became more lively, but we had no casualties. The batteries came on, doing all they knew; the last thousand yards was through high crops. I assigned the positions, and added: "Hurry up; here's a chance for Iron Crosses; shoot at everything down there, standing or on the move. Right battery, cyclists; center, artillery; left, cavalry." The men were at the highest pitch of enthusiasm; everyone felt that fire-effect took precedence of cover here.

My Abteilung came into action as if on parade; we had constantly practised this method. The first shots rang out almost immediately; and, though a little short, they worked like hot coals thrown into an ant's nest. The cyclists pedalled for all they were worth; then came the next shots, which produced visible effect; empty cycles, dead, and wounded. Some of them very properly dismounted and took cover in the ditch by the roadside; the others less wisely sought safety in flight, but found themselves only riding towards destruction.

In the meantime the center battery had come into action and opened fire on the artillery halted in the field. These at once mounted and tried to escape, but the shrapnel followed them, as the trees on the high road gave little cover, and the ground behind the high road was open. The guns galloped to right and to left; two were hit and brought to a standstill under our fire, others sought to escape to Ogévillers under the shelter of the trees bordering the road. We could see the whips lashing and the men riding for all they were worth. The cavalry were the first to disappear; as soon as the first shots fell near them they mounted and galloped

for it, plainly without orders and in wild confusion, thinking of nothing but their own safety.

Up to this point the rapid fire of my batteries had not been answered by the French artillery. All were intent on doing as much damage as possible to the unwary enemy: it was like battery practice. I was directing the fire, so far as this was possible for the deafening noise of the guns; I went through the batteries and interfered wherever I saw the shots going astray. Then suddenly the first shell from the enemy came whistling from some unseen position, and was quickly followed by the second, third, and fourth. They all burst about 150 yards short of my batteries; shrapnel, burst very high, and therefore almost ineffective. "Here we are at last!" I thought to myself, eager for the duel. For years past, at practice and at the School of Gunnery, we have all watched the effect of thousands of German shrapnel, both from the firing point and from the range. We have all formed a clear idea of the material and moral effects of the burst, and of the appearance of the bullet cone sweeping the ground. But what I saw here was very far short of my expectations, and the same impression continued to the end of the fight. Things became interesting as, standing with my staff behind the brigade observation wagon, I watched the ranging of our enemies. We were on the crest of the hill, almost without cover, and offered a splendid target—which we never do now! The second "collective" group of French shrapnel was some 100 yards over, in accordance with their regulations. Bullets and splinters hummed down the slope behind us, reaching nearly as far as the limbers, but, so far, without effect.

It was quite plain to me that the bullet-cone of the French shrapnel is far less dense than that of our own, and that many bullets are ineffective, going up in the air to drop harmlessly far from the point of burst; and I have had no occasion to modify this opinion since. There was nothing like the "hail of bullets" produced by a properly-burst German shrapnel. After some two minutes of ineffective shrapnel fire, the first high-explosive shells began to arrive; instead of the white balls of smoke in the air, we had the black clouds produced by the shell on impact, with the accompanying deafening detonation. The French shells were getting closer and closer; soon they would be pitching in the batteries. I was curious to see the result, but the gunners seemed indifferent. At last we got a "*rafale*" right into our center battery; I saw the splinters striking both short and over and heard them rattling on the gun-shields. One shell pitched about 5 yards behind a gun, burst, and covered a gunner who was bringing up ammunition baskets with earth; he stopped for a moment, shook off the clods, and then carried his baskets to the gun as if nothing had happened. I could see the ammunition numbers crouching closer behind the wagon shields, and they were now digging up earth to fill in the space between gun and wagon.

Part of our adversaries in the foreground had vanished, or were lying in the roadside ditches, seeking cover from our overwhelming fire. The tail of the cyclist column could be seen disappearing into the village. I immediately ordered fire to be opened with high-explosive shell on the exit from the village, in order to oblige them to halt there, and to block their retreat. It was there that we afterwards found that most effect had been produced, both on the cyclists and on the flying cavalry. Our advanced cavalry patrols, who had witnessed the whole affair from points quite close to the village, testified to the effect of our fire and to the panic

produced by it, which was increased when the houses were set on fire by our shells.

In the meantime the enemy's shell fire grew hotter and hotter, butt he comparatively trifling effect increased the confidence of our men; they loaded, aimed, and fired more steadily. Yet even a quarter of an hour after we had opened fire we were still unable to locate the French batteries; there must have been several of them. We reconnoitered the whole country with our 'scissors" telescopes,—hills, woods, and villages. I thought I saw some movement on a church tower, and some smoke behind a light-colored roof. I put the nearest battery on to it. The director under officer, a young ensign, measured his angle and manipulated his clinometer as steadily as if on the drill ground, and soon our shells began to pitch in the village, where the barns, full of fodder dried by the summer heat, soon blazed up. The enemy's fire then seemed to slacken a little.

Now we had to begin our search afresh, and to re-distribute our fire on the targets still remaining. Then we suddenly became aware of a new sound, the boom of a heavy shell, followed by three or four more, which pitched on our exposed flank. Then came a mighty explosion just in front of our guns, with a huge cloud of dust and flying splinters. A glance to the right explained it; we were under the fire of the heavy guns in Fort Manonviller, which enfiladed us. We were a conspicuous target, exposed to the enemy's cross fire. In a low voice I told the battery commander next me what had happened—always a sound thing to do—and consulted with him. There was only one thing to do, namely to get behind the hill and out of the line of fire. I ordered the guns to be run back, no easy job in the heavy plough, and for the long distance we had to cover. Fortunately the enemy's heavy shells were all pitching in front of the batteries; he had not quite got the line. A single hit might have done a deal of damage. There is good reason to believe that Fort Manonviller had got the position of my batteries by telephone from one of the villages possibly from Chazelles, close in front of us. His patrols, or the civil population, would have sent him a message, as we often found they did later on.

"Enemy's artillery on Hill 297 N.W. of St. Martin;" the gunners in the fort (which, a fortnight later, was wrecked by our 16.5″ howitzers) had only to revolve their cupolas to a certain figure, and fire could be opened at once at the known range. And no doubt this is what happened. If the enemy's object was to draw us under the fire of his fortress guns by a premeditated retreat, he fully succeeded; only his six-inch guns should have shot a little better.

Two batteries had retired behind the hill, and were re-fitting. One battery commander assured me that his men had never run back their guns so fast in peace time, and the heavy wagons as well! In the hurry of our retreat we left a number of ammunition baskets on the ground, but these were almost all fetched in afterwards. The third battery, which was out of sight of the fort, remained in position for the present, firing at the target opposite to it.

The enemy's shells from the fort had now reached our limbers, standing far behind us, and these moved off at a walk to a flank and to the rear, not without losses in men and horses. The French field batteries, according to their custom, had begun to sweep, and were now searching the whole country. Several of their shrapnel burst among our cavalry, who had withdrawn to the right to escape the enemy's searching fire, and did con-

siderable damage. There was naturally some disorder, as the horses stampeded under the rain of bullets. But the regiment soon rallied and reformed.

Still we had not succeeded in locating the enemy's field batteries. I ordered observation to be continued, and I had the direction of the scoops made by the shells in the ground noted. These showed that the enemy was firing from at least two directions. I also picked up a French fuse, but this was graduated in seconds, not in meters, so I learnt nothing from it. (The French range tables were not issued to us till later.)

Fort Manonviller fired about 20 rounds at us in all; some of these pitched among the machine guns, which were in line on our left, but without doing any damage.

At this moment, after our fire-combat had lasted about half an hour, a staff officer of the division rode up and shouted to me: "The division is retiring towards Chazelles; your Abteilung will follow, protected by the 26th Brigade." I passed on the order to the batteries, and ordered the limbers up, in order to limber up under cover. This took some time, owing to the casualties among the horses and the long distance to be covered. It took still longer to get the staff horses up; these had hidden themselves in a fold in the ground. At last we were limbered up, and retired at a walk; teams which tried to trot on prematurely were checked by the battery commanders, and so two batteries withdrew steadily and in good order from the enemy's fire, which had somewhat relaxed since we retired from the crest of the hill. We found a wagon of the 3rd H.A. battery with the leaders shot, and a limber for which we also had to get a team. When we had cleared the village, I heard heavy firing from our original position, which I could not understand. It was not till we had gone two miles that a mounted orderly from the 2nd H.A. battery overtook us, and asked for ammunition from the light column, as their ammunition was running out. To my astonished question: "Has not the 2nd battery limbered up and followed the others?" he replied that it had not done so, and that no order to retire had reached them.

Although the batteries were in action close alongside one another, so that in peace time they could not have failed to see the next battery limbering up, yet our left battery was so engrossed with the enemy that no one had noticed the withdrawal of the rest, and the battery remained alone under fire, where an energetic adversary might easily have captured it. *The order had not got through.* No visual communication was possible owing to the ground, and, in the hurry of the fight, where everything depended on quick action, the telephone lines had not been laid; although the Regulations lay down that this is to be done in the open as well as in the covered position. It was a sort of "pursuit" or "surprise" action, from which I learnt a lesson for future procedure.

I was naturally very anxious to get my battery back, and sent immediately to fetch it. We halted behind the village, and I rode down the two batteries, which had dismounted, and enquired about the casualties. The junior subaltern of the 3rd battery reported to me that the captain and senior subaltern were missing and probably left behind wounded; this, however, was not the case. It turned out that they had stayed to bring off a wagon which had been left behind, which they would not under any circumstances abandon in the enemy's country. Just then His Excellency the G. O. C. Division came up, and asked about my casualties, which I

reported as slight. I had to report that the two officers were missing, and the news of this soon spread through the Division.

The 2nd H.A. battery, which had fought the enemy alone for more than half an hour, came up at last; I was very glad to see them, and, as it turned out, they had hardly lost a man.

On the day of our baptism of fire we had not acquired any great respect for the enemy's artillery fire, even for that of his heavy guns. For when the actual effect is slight, the moral effect soon vanishes. Everyone in the Abteilung had the same cheerful feeling: "If we get off as easily as this, and if the French can't hit us even in an open position, then we have nothing to fear in our future battles." But there were days afterwards when the French *did* shoot a great deal better, and compelled us to respect their methods, especially their quickness in ranging. Such a day was that of St. Martin.

On our way back to our quarters I got a note from our C.R.A., who had followed our fight with his glasses from the heights at Igney. After seeing the heavy fire directed on us he was prepared to hear that his Horse Artillery Abteilung had been badly cut up, and he expressed his thanks to us for holding out so gallantly. But what pleased us most was the conclusion of his note: "The enemy's cavalry division has fled in disorder by the road to Lunéville, showing distinct signs of panic and serious losses."

Besides this gratifying message, it was a pleasure to us to receive the thanks of the cavalry, and their generous recognition of our efforts. This good feeling was maintained throughout the subsequent weeks, when we fought together shoulder to shoulder.

Such was our baptism of fire; a brilliant and conspicuous success, such as we had but few chances of achieving in the days that followed.

—*The Journal of the Royal Artillery.*

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THE UNITED STATES DREADNOUGHT *NEVADA*

The latest dreadnought of the United States Navy to be completed and go through her trials is the *Nevada.**

The *Nevada* possesses several distinctive features which, taken together, are sufficient to render her a type ship, marking a new era in our battleship construction. In the first place she mounts the 3-gun turret—a new type in our navy, which has also been installed on several of the latest ships of foreign navies. The second innovation is the unusual thickness and wide distribution of the heavy armor on this ship; nothing approaching it can be found on any other dreadnought of contemporary design and construction. The third notable feature is that the ship uses oil fuel, all of the boilers being oil-fired and no coal whatever being carried for the motive power of the ship.

The main battery of the *Nevada* consists of ten 14-inch guns, six of which are mounted in two 3-gun turrets, one forward and one aft; the other four being carried in two 2-gun turrets, the latter mounted of such a height that their guns can fire across the roofs of the adjoining 3-gun turrets. The torpedo-defense battery consists of twenty-one 5-inch guns mounted

* See frontispiece.

on the main and berth decks. This ship also carries four submerged 21-inch torpedo tubes.

The guns of the 3-gun turrets are mounted in a common sleeve, and, consequently, they are rotated in the horizontal plane and elevated as one gun. To prevent the blast at the muzzles of the guns interfering with the true flight of the projectiles, matters are so arranged that the center gun of the three is fired a small fraction of a second after the outer two. In addition to the saving of weight in the 3-gun turret, there is the advantage that spotting the fall of the shot is simplified, the observation for one shot being good for all three.

The *Nevada* and her sister, the *Oklahoma*, are the most heavily armored ships afloat to-day. They carry a belt which is 13½ inches thick amidships and is 17½ feet wide, 8½ feet of the belt being below the load water line. The barbettes are protected by 13 inches of armor and the turret armor is from 9 to 18 inches thick on the triple turret and 9 to 16 inches thick on the double turret. A valuable feature is the protection of the base of the single smokestack by inclined armor which extends from the gun deck to the forecastle deck. The conning tower is also protected by 16 inches of armor.

The great beam of the ship and the fact that no space is taken up in the wings by coal bunkers, make it possible to group the whole of the boiler equipment amidships and lead all the uptakes to one large smoke-stack. The batteries of boilers, as so assembled, are grouped in several separate apartments formed by running transverse and longitudinal bulkheads throughout the boiler spans.

The *Nevada* is driven by Curtis turbines, the sister ship *Oklahoma* being furnished with triple-expansion, reciprocating engines. The fuel tanks are capable of carrying 2000 tons of oil. The normal displacement of the *Nevada* is 27,500 tons and the full load displacement 28,400; the complement of officers and men is 863.—*Scientific American.*

"SUBMARINE CHASERS" FOR THE BRITISH NAVY

Among the many defensive methods which have been adopted by the British Admiralty against the German submarine attacks on merchant shipping was the creation of a large fleet of small motorboats, each armed with a rapid-fire gun. These crafts were distributed methodically over the areas which were known to be infested with submarines, or along the routes by which they approached and left their hunting grounds, and the moment they sighted a periscope or the hull of the submarine as she approached the surface, they made a swift dash for her and opened fire with the hope of penetrating or breaking off the periscope, or better yet, holing the hull of the vessel itself.

This mosquito fleet was built very rapidly—orders being widely distributed. Our illustration shows three of the "submarine chasers," part of an order of forty, which were built at Lawley's yard, Boston, which have been shipped to England for use in guarding the coasts of Great Britain. There were six in the first shipment. All of these craft are named after various fish of the sea. They are 100 horse-power, gasoline launches of uniform design, capable of making twenty-five knots. The contracts

were awarded last Spring, and it is stated that they cost $4,000 each. They have a strongly-built deck forward, for the purpose of mounting a rapid-fire gun, probably of three inches, and below is a commodious trunk cabin

Three of the fast motor boats, known as "submarine chasers," 1765
built for running down submarines and sinking them by gun fire

containing accommodations for two or three men. They are of the V-bottom type, and the motors are equipped with a special carbureting device, by means of which either gasoline or a heavy oil may be used.

—*Scientific American.*

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ACCURACY OF FIRE

The Principal Causes Affecting the Fire of Big Guns

In an article in *The Engineer*, Captain H. J. Jones, inspector of ordnance machinery of the British Army discusses the factors affecting the accuracy of fire and range of big guns, and gives some causes that will explain the apparent haphazard shell fire that we read of in the reports from the war, and why the shots from big guns so frequently miss their mark.

BALANCED ERRORS

1. *Whip.*—The whip or transverse vibration of the muzzle portion of long guns may be the source of very large errors. It becomes pronounced with 50-caliber guns, particularly if they lack girder stiffness. The droop of a 12-inch 50-caliber gun is from 0.3-inch to 0.4-inch, and its cantilever stiffness such that it makes from 130 to 150 complete vibrations per second. The velocity of the center of the muzzle across the line of departure arising from this vibration may be as high as 50 feet per second with wire-wound

guns. Assuming the mean velocity along the rifling to be about 1800 feet per second, we see that there will be about three complete vibrations of the muzzle while the projectile is in the gun. The projectile may leave the bore with the center of the muzzle in any position between its limits of vibrational displacement, and the error in the angle of departure is thus quite indeterminate and fortuitous, and the error of range symmetrically disposed about the mean.

2. *Firing Interval.*—This is the interval between the layer pressing the trigger and the projectile leaving the bore. With moving gun platforms it is the main cause of inaccurate shooting. The firing interval is made up of two parts; one, from 0.08 to 0.13 second, during which time the tube is fired, the charge ignited and the band engraved, and the other, from 0.022 to 0.035 second, representing the time of travel of the projectile along the rifling. In other words the firing interval for a modern 12-inch is, on the average, about 0.122 second. These figures, however, may be greatly exceeded with defective tubes and firing arrangements.

Modern battleships have a metacentric height of from 3.5 feet to 4.5 feet and a period of about 8 seconds for a single roll of 5 degrees. This is equivalent to a maximum angular velocity of 15 minutes of angle per 0.10 second. Hence, if we assume that the layer does not alter the elevation between the instant of pressing the trigger and the projectile leaving the bore, the average firing interval means a possible error with the 12-inch of 16.3 minutes elevation. Since 1 minute alteration of elevation at 10,000 yards corresponds to about 15 to 20 yards on the water, we see that, due to a moderate roll of 5 degrees, every round may be a miss, although the marksmanship of the layer be perfect. Under such conditions, firing for individual hits is the merest futility; firing by salvo becomes imperative.

3. *Air Spacing.*—When using reduced charges a considerable space exists between the end of the charge and the base of the shell. Wave pressures are likely to be set up, giving rise to irregular burning and irregular muzzle velocity.

4. *Propellant.*—The acceptance limits of a lot of new powder define the probable variation of muzzle velocity from round to round. These limits become extended when lots of varying ages of different makes are in use, and speaking generally, the mean velocity from any one lot shows a progressive fall with age.

5. *Projectile.*—Those qualities of projectiles which affect the ballistic coefficient—size, weight, balance, etc.—will vary from round to round. The limits of variation are determined mainly by questions of expense in manufacture and inspection.

6. *Steadiness.*—The coefficient of steadiness is affected by the position of the driving band, the position of the center of gravity with relation to the center of form, the speed of rotation, initial centering, and the actual gun elevation. Projectiles in the descending branch of high-angle trajectories become increasingly unstable as the elevation is increased.

SYSTEMATICALLY LOADED ERRORS

1. *Laying.*—As a rule layers have a personal prejudice for laying either high or low, and in a bad light, in rain and mist, or when fatigued, excited or impatient, they tend to exaggerate their specific defect. All laying depends on the personal judgment of the layer—the attainment of a state of mental satisfaction, in which a condition of equilibrium is estab-

lished between the feeling that "that is near enough," and the adjustment of muscular effort required to make it nearer. Most heavy guns are more easily depressed than elevated, and when following a target in a seaway the gun tends to take charge in depression and is a very fatiguing mass to control in elevation. When laying by clinometer, if the bubble be very lively, the layer becomes impatient, whereas if the bubble be sluggish the error of elevation depends on whether the last motion of setting be in elevation or depression.

2. *Jump.*—Jump is very considerable with field carriages on bad ground, and in the case of naval mountings varies not only with the same mounting in different parts of the ship, but also when the gun is trained on different bearings. Mountings carried on a pedestal with a ball race of small diameter, particularly if they are balanced mountings, are extremely unstable, the jump varying between positive and negative limits of as much as half a degree. Errors of elevation with these mountings are also caused by the movements of the gun members on the platform and by the tilting of the mounting by the thrust at the elevating arc. With hydro-pneumatic mountings the recoil and angle of departure are greatly affected by the mere rate of fire, the frothing of the liquid and the liberation of air being dependent on the time interval of rest between the rounds.

3. *Dials.*—The dials are graduated from a calculated range table that has been correlated to the shooting of one or more guns of the particular nature. Any individual gun, however, may range consistently short or over, due to some peculiarity not possible to define.

4. *Instruments.*—There are a considerable number of instrumental errors which arise mainly from imperfect adjustment, such as telescopes out of collimation, displacement of the zero reading of dials, range finders out of level or incorrectly datumed, tide gages incorrectly set, etc., that give a permanently loaded error to the shooting of the gun.

UNBALANCED ERRORS

1. *Droop.*—This is caused by the heat strains of unequal cooling during manufacture or by a lack of girder stiffness. In both cases perceptible modifications of the droop are brought about during firing or by the heating effect of mere sunshine. Cases have been met where the bend of field guns is beyond the condemning limit when measured in the gun park, but four or five minutes less after the guns had been heated by exposure to a tropical heat for three hours.

2. *Choke and Metallic Fouling.*—The effect of choke and metallic fouling is not only to increase bore resistance and thus cause variable muzzle velocities, but also to make one gun differ from another of the same nature at the same period of its life. The effect depends on whether the choke or coppering occurs in such a position that the rate of burning of the charge is affected by lowering the normal rate of expansion of the bore gases. Heavy guns which copper rapidly may lose as much as 50 yards per round at 5000 yards.

3. *Driving Band.*—When projectiles are fired for recovery their driving bands are found to be fanned, eccentric, worn smooth or multiply engraved. This irregular action implies variable engraving and rifling resistance, and, in consequence, variable muzzle velocity. In addition, with long shell or with a gun eroded at the commencement of the rifling oblique loading results, and heavy groove marking on the body of the shell itself.

4. *Wear and Windage.*—Wear at the commencement of the rifling gives rise to over-ramming and to an engraving resistance less than that normal for a new gun. Heavy guns have a rapid rate of wear and rapid rate of fall of muzzle velocity for about the first eighty rounds of their life, a feature that is not exhibited by guns below about 5-inch caliber, these latter having a gently diminishing rate of fall of muzzle velocity throughout their life. General wear of the bore gives rise to gas escape, fusing of the driving band, irregular rotation and a fall of muzzle velocity.

5. *Wet Chamber.*—This is a fruitful cause of lack of agreement between performance and intention. When charges are burning in a gun the principal mode of heat loss to the walls is by radiation. The magnitude of this heat loss is not generally appreciated, although it is of the order of 10 per cent of the total heat of combustion. The most important practical fact to remember, however, is that the rate of absorption of radiant heat greatly depends on the mere condition of the surface, differences of polish or of wetness hardly perceptible to the eye causing a considerable change in the rate of heat transfer. Water in the chamber affects the ballistics in two ways. Water being opaque to radiant heat reduces the initial heat loss to the walls by radiation, and water left in the chamber after sponging out absorbs heat on being converted into steam. The initial greasiness of the gun, in its effect on radiation, may explain the "mystery" of the first round. The quantity of water left in the chamber depends largely on the drill, and also on the shape of the chamber and the elevation of the gun. Quick-firing guns with fixed ammunition are not liable to this source of error.

6. *Ramming.*—Just as an over-rammed projectile causes a loss of muzzle velocity, so also does the slipping back of a projectile cause a rise of muzzle velocity. A 6-inch shell, slipping back 6 inches, may be expected to give a maximum pressure of 1.5 ton above the normal and an increase of muzzle velocity of about 60 feet per second.—From *Scientific American Supplement* in *Proceedings of the U. S. Naval Institute.*

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PERMANENT FORTIFICATIONS IN THE PRESENT WAR*

Translated by 2nd Lieutenant SYDNEY S. WINSLOW, C. A. C.

The well known writer, Frobenius, has published in *Kriegstechnische Zeitschrift* the following article on the fortresses of France and Belgium in the present war.

A number of fortresses, such as Lille, Laon, La Fère, and Rheims were evacuated by their defenders without firing a single shot. This was apparently done more because the generals in command wished to use their garrisons to increase their field forces than because of lack of confidence in the works themselves.

At Namur the Germans brought up thirty-two pieces of modern artillery to a point about five kilometers from the Belgian lines, and placed them in two groups so that all concentrated their fire on a single sector. The defenders took refuge in their trenches and did not attempt to return the fire. Fort Maizaret, situated on the left bank of the Meuse, fired only ten shots, receiving in return 1200 shells at the rate of 20 a minute. Forts

* Furnished for publication through the courtesy of the War College Division, General Staff.

Cognelée and Marchevolette, situated on the right bank of the river, formed the northeast sector. These received the fire of the German 42-centimeter mortars and the Austrian "Skodas." Fort Suarlee, on the northwest, was bombarded by three heavy batteries. Between the morning of August 23rd and 5 P. M. on the 25th, when the place surrendered, these batteries fired 3500 shells.

The diary of these forts can be briefly summed up:

On August 21st, the German infantry attacked and forced a retirement from the advanced positions. On the 22nd, the artillery fire of the attack became effective and the fire from the forts decreased. On the 23rd, the German infantry again advanced while the field artillery attacked the lines of communication between the forts. On the 25th, the artillery attack reached its maximum and forced the surrender of Fort Maizaret. The infantry attack was directed at the intervals between the forts and penetrated into the city. On the 26th, the fire from five forts was silenced, the other four surrendered, and the city was completely occupied. Some 26,000 defenders retreated before the surrender but were later captured at Bois-les-Villers.

The principal features of the attack were: silencing the artillery of the defense; the destruction of the superstructure of the forts; the advance of the infantry, covered by their artillery; and the penetration of the intervals between the forts. No assaults on the forts were necessary.

Forts Suarlee and Cognelée were armed with two 21-centimeter howitzers, in armored casemates, two 15- and four 12-centimeter guns. Maizaret and Marchevolette each had one 21-centimeter mortar and two 12-centimeter guns.

At Maubeuge they had all necessary equipment to bring the defenses up to the highest state of efficiency. The forts had concrete and metal turrets with intervals well prepared, and barbed wire was used extensively, so that they formed an excellent line of defense. An armored train ran around the gorge of the principal line of defense.

The German infantry appeared before Maubeuge on August 25th, but remained inactive until September 3rd. On that day the attack was begun by the artillery, and the infantry took position two kilometers from the outer works. Three forts surrendered on the 6th and the city on the 8th, with some 40,000 prisoners.

The principal phases of the attack were the siege; bombardment with heavy artillery; advance of the infantry; attack of the lines between the forts, penetration of this line; and the reduction of the fortress. These phases succeeded each other with great rapidity.

The situation at Antwerp presented an unusual feature, in that the defending force was more than triple that of the besiegers. Apparently the Commanding General had no conception of the fundamental principles of the defense of a fortified place, and was satisfied to present an entirely passive defense to the impetuous German offense. The forts were constructed in accordance with the principles of Brialmont, concentrating great power in small areas. The defense lived up to these same ideas, and the result was a calamity. The hope of Antwerp lay in keeping the German heavy artillery from locating the vital features of the defense. An attempt should have been made to cut the line of communication of the besiegers. The defense was so passive that no serious attempt was made even to

hinder the German engineers in their work of building bridges over the flooded areas near the forts.

It can be stated as a general principle, that, if a besieging army is as well equipped with heavy artillery as the Germans were, and the defense is weak in artillery, the garrison must maintain a very active exterior defense and prevent him from properly emplacing his artillery. The idea that the strategic value of permanent fortifications lies in themselves need not be abandoned, but there must be a mobile force to work in front of the forts. It is also essential to fit the fortification into the terrain, to lower the height of the parapet, seeking concealment of the works above all else, and to distribute the defensive elements over wide areas.

—*Memorial de Ingenieros del Ejercito.*

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AN IMPROVISED TELEPHONE SWITCH-BOARD

By Major G. K. Gregson, R.F.A.

We are continually having to cudgel our brains here to produce the necessary "straw" for our "bricks" and a short description of a telephone switch-board made from such "straw" may be of interest.

The number of lines to the principal observing station of the battery grew fairly quickly to more than we could manage with our available instruments.

A switch-board and exchange became therefore the only possible solution. It was made as follows, vide sketch:

a. Is a strip of metal cut from an 18-pr. cartridge case.

b. Are 5 small metal plates from the same case. The long strip and the small plates are secured to a board by means of screws (*e*) from an 18-pr. cartridge box, and by the terminal *f.*

Holes (G) for plugs *C*—the latter being empty .303 cartridge cases—are drilled through metal and board. To prevent these plugs from being lost they are attached by pieces of string to the loops (*h*) of 5 No. 82 fuse pins fixed into the top of the board.

The lines from the 5 stations are each brought through a hole (*i*) in the bottom of the board, and attached to one of the screws (*e*).

The actual stations connected to the board are:

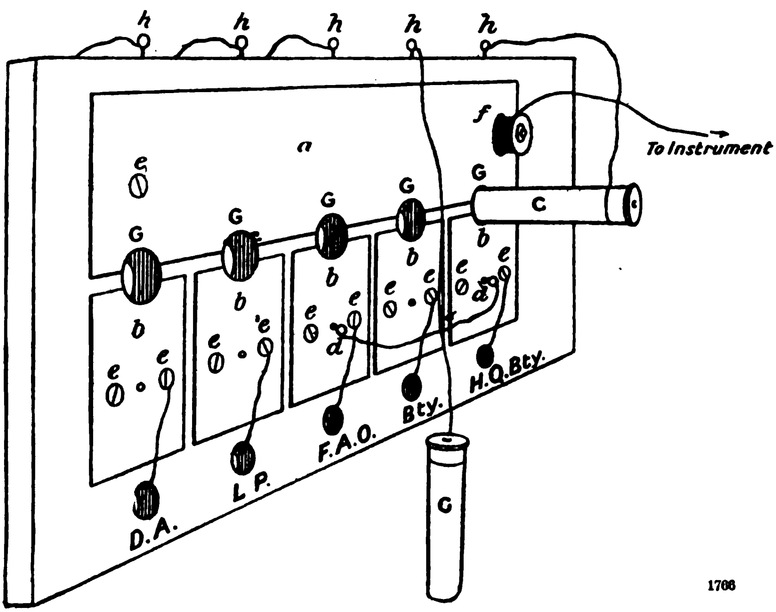
I. Divisional Artillery Headquarters (D.A.).
II. F.O.O. No. I. (L.P.)
II. F.O.O. No. I. (L.P.)
III. F.O.O. No. II. (F.A.O.)
IV. The Battery.
V. Brigade Headquarters.

It is obvious that any one of the stations can be spoken to, the remainder being cut out for the time being to prevent confusion. Also any one station can speak to another, and it has been found that with an additional circuit made of two fuse pins (*d*) and a short piece of wire, the connection was much improved. Each of the 5 plates (*b*) is bored in the center with a small hole to take these pins.

A line from (*f*) connects to the one instrument. A bayonet (we have plenty of Turkish ones) makes a good earth pin.

The arrangement is specially useful when targets appear in the zones of observation of F.O.O. I, and F.O.O. II, which are invisible from the main observing station. F.O.O. is then connected with the battery, and a gun or section placed under his direct control. The battery commander is able at the same time to check F.O.O.'s orders and control the fire.

Four lines connect main observing station with battery. Two are always in use. Both these and one emergency wire are air lines. There is also one buried emergency wire 18" underground all the way. In the heaviest bombardment here we had only 3 of these lines laid and all were cut—two early in the battle, and the third about an hour afterwards. Communication was maintained by means of a short buried wire from observing station to a signal station whence orders were sent by lamp during the



remainder of the night and by flag when it grew light. The signal station was exposed to a good deal of searching shrapnel and H.E. fire and the signallers displayed much coolness in getting the orders through. Recourse has since been had to this wire on one or two occasions. It is still in existence and forms a third reserve line.

Only one line at present connects each of the other stations to the observing station.

Battery commanders quarters are midway between observing station and battery and both lines in use between these positions are tapped into by short lines communicating with a telephone box near his dug-out. From here by the exchange he is able to speak to any of the stations.

We find the old Stevens telephone instruments, with which we are provided, double the work and are a constant source of anxiety—as they invariably get out of order at critical moments. My advice is, stick to the "D" III instruments, which we were robbed of at the last moment by fair means or foul.—*The Journal of the Royal Artillery.*

THE REPORT OF COUNT SPEE ON THE NAVAL ENGAGEMENT NEAR CORONEL, NOVEMBER 1, 1914

Translated from the German for the JOURNAL U. S. ARTILLERY
by Captain SAMUEL G. SHARTLE, Coast Artillery Corps

The division under me, consisting of the large cruisers *Scharnhorst* and *Gneisenau* and the small cruisers *Nürnberg, Leipzig,* and *Dresden,* proceeded November 1 at 14 sm.* speed about 20 sm. distant from the Chilean coast toward the south, in order to intercept a small English cruiser, which, according to reliable information, had come to anchor there the evening before. On the way, small cruisers were several times detached on the flank in order to observe casual steamers and sailing vessels.

At 4:15 P.M., on such errands, the S.M.S.† *Nürnberg* had gotten out of sight toward the northeast; and the S.M.S. *Dresden* had remained back about 12 sm. I was about 40 sm. north of the Bay of Arauco with the main body.

At 4:17 P.M., in a southwesterly direction, first two, then at 4:25 a third ship, distant about 15 sm., were sighted; of these two were soon recognized as warships, presumably the *Monmouth* and *Glasgow,* while the third was likely the auxiliary cruiser *Otranto.* They appeared to be holding likewise a southerly course.

The division gave chase at top speed, holding them about 4 points to the starboard. The wind was blowing from the south, 6 ms.‡ strong, the sea and spray were correspondingly heavy, so that I considered it important not to be forced into the lee position. The chosen course served also to cut off the way for the enemy to the neutral coast. About 4:35 it was noted that the hostile ships bore more toward the west and I followed gradually until I had a west-south-west course, during which the *Scharnhorst* with revolutions for 22 sm. slowly came up, while the *Gneisenau* and *Leipzig* lagged. The lively wireless communication of the enemy was disturbed as much as possible.

At 5:20 the approach of another warship was reported, which at 5:30 placed herself in the lead and was recognized as the *Good Hope,* flagship of Rear-Admiral Craddock. The hostile line now disposed itself, set top flags and sought a slow approach on a southerly course. From 5:35 I bore gradually to a southwest course, later to a southerly course and decreased the speed in order to let my own ships come up.

At 6:07 the two lines (the *Dresden* still about 1 sm. astern), as far as the *Nürnberg,* which was far away, stood opposite each other on an almost parallel southerly course at a distance of 124 hm.|| (13.5 km). At 6:20, at a range of 124 hm. I made a 1′ turn toward the enemy and at 6:34 P.M. opened fire at 104 hm. The wind and sea were head on; the ships labored, particularly the small cruisers of both sides.

Observation and range finding suffered here very much under the seas, which dashed over the forecastle and conning tower; and the high pitching spray concealed the target for the 10.5 R.F. guns on the main deck so that the stern of their enemy not at all and the bow only now and then could be seen. On the other hand, the artillery of the two armored cruisers could be used throughout and shot well; the first hits, on the *Good Hope,* could be

* Sm. = sea mile, nautical mile.
† Seine Majestat's Schiff—His Majesty's Ship.
‡ Meters per second; 6 ms. = 13.4 miles per hour.
|| Hm. = hundred meters.

observed at 6:39. I thereupon immediately turned back to a parallel course. The English first opened fire at this time; I suppose the bad sea made more difficulties for them than for us. Their two armored cruisers remained practically covered by our fire, although with decreasing ranges it began to get dark; while they, so far as ascertained at present, hit the *Scharnhorst* only twice and the *Gneisenau* only four times.

At 6:53 P.M., at about 60 hm., I turned (at 60 hm. range) 1 point away from the enemy. His artillery fired at this time more slowly, while we could observe numerous hits. Among other things, it was observed that on the *Monmouth* the turret deck of the forward double turret was raised up and that there was a strong fire in the turret. The *Scharnhorst* believes that she can reckon for herself 35 hits on the *Good Hope*.

Since the range in spite of our bearing off still decreased to 49 hm., it was assumed that the enemy despaired of success with his artillery and was maneuvering for a torpedo shot. The position of the moon, which had come up toward 6 o'clock, favored him for this. I therefore withdrew the division at about 7:45 by bearing off gradually with the leading ship. Meanwhile, it had become dark; the range finder on the *Scharnhorst* still used the glow of the fire broken out on the *Good Hope* as a measuring point, but gradually range finding, corrections, and observations became so inexact that firing was stopped at 7:26. About 7:23, on the *Good Hope*, a heavy explosive column between the smoke stacks was observed; from this time, the ship, as it seemed to me, fired no more. The *Monmouth* appears to have ceased firing at 7:20.

The small cruisers, including the *Nürnberg*, which must meantime have come up, received at 7:30 an order by wireless to follow the enemy and attack with torpedoes. Visibility was at this time affected detrimentally by rain squalls. The small cruisers did not succeed in finding the *Good Hope;* on the other hand, the *Nürnberg* came up with the *Monmouth*, which badly damaged ran first before then beside her and was caused to capsize at 8:58 by shooting at close range, without the fire being returned. Her flag still flew however.

Rescue work was not to be thought of in the high sea; and further the *Nürnberg* thought she saw immediately behind her smoke clouds of a second enemy and must here make a new onset. The *Otranto* had at the beginning of the fight, after the first hits, turned away and apparently escaped at full speed. The *Glasgow* had been able to continue her fire, really ineffective, longest, and then escaped in the darkness. The *Leipzig* and *Dresden* believe they observed several salvos hit her.

The small cruisers have suffered neither losses nor damage in the fight. The *Gneisenau* had two slightly wounded.

The crews of the ships went into the fight with enthusiasm; each has done his duty and has had a share in the success.

—*Artilleristische Monatshefte.*

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THE EXPANSION OF THE ROLE OF ARTILLERY; HEAVY ARTILLERY IN FIELD WARFARE

Nothwithstanding the failure, at the very beginning of the war, of several tactical principles which are now almost completely rejected, here in the military press, they are still referred to as fundamental ideas.

In every war several tactical principles, laid down in the regulations are upset.

Now, not only those actually present on the actual theater of military operations, but everyone has to admit, that not, "only well-trained infantry alone can ensure the success of an army and of a nation." The trained infantry of all nations is good, but the very best infantry, when alone or helped by indifferently trained artillery or cavalry, is sometimes found to be of no avail against well-trained and well-armed artillery (heavy or otherwise).

Also all must observe that artillery and infantry so closely are intimately connected on the battlefield and well remembering the principles of mutual support and aid, are striving for one common object; the fighters are not the different arms, but the commanders of detachments, armies and the higher formations; the different arms play the chief or an auxiliary rôle, in accordance with the object in view and the situations and not just as it pleases them, but under the direction of those commanding.

Thus we have seen the German artillery playing the leading rôle in one or two places and when attached to the rear-guard and accompanied by a small party of infantry as an escort in the case of a sudden attack by cavalry.

Besides, we have seen the like in the Russo-Japanese war when the Japanese in certain portions of the field, acted solely by artillery fire (11-inch) because they had used up all their infantry in an enveloping movement.

As is evident from letters of German officers, picked up on the battlefield, the Germans themselves give the credit for the capture of Antwerp to the artillery. And all our officers and lower ranks with one voice affirm that if it was not for the enemy's heavy artillery we should long ere this have reached Berlin and Vienna.

We all see and cannot dispute the advantage of allotting heavy artillery to the advance guards in the case of the Germans, and of its transport on motor lorries when the advanced and aerial reconnaissance is well organized. And can anyone dispute the advantage of being able with impunity, to bring the enemy to a halt at a distance of 10 or 12 versts, and to compel him to deploy, at the same time condemning his field artillery to inaction, and not allowing it to approach within its effective range.

Thus, when the German heavy artillery begins to sprinkle one with "coal-boxes" at a range of 10-12 versts, and compels its opponent to deploy, this action can be countered either by heavy artillery, by maneuver, or by night attacks.

Some sort of counter-stroke is essential, which will render the use of this arm disadvantageous and dangerous to the enemy. To this one must devote serious attention.

And how indeed can one compete with heavy artillery when you have none yourself. Generally at that point the field or light artillery is brought into action. But obviously this is not expedient, in the same way as it would not be expedient to match field artillery with rifles. The light battery in action against the heavy—is more vulnerable than infantry and even than cavalry. Only the most daring journalists, as for instance the "special correspondents" of several non-military though quite staid and sober papers can write, that a light battery successfully engaged for two days two heavy batteries and even silenced them and almost captured them afterwards.

The feeling of irritation that the reading of such nonsense would rouse in one who has been fighting without respite with heavy artillery, and who

has been almost daily under its fire or observing it, is easily to be understood. Such statements are also injurious, owing to their instilling false ideas, as for instance, that a light battery is stronger than two heavy batteries, etc.

To begin with, the shrapnel fired by light artillery are not at all fearsome to other protected light artillery and for the well-protected heavy artillery—even less so. Splinters from the "coal-boxes" literally tear the shields like cigarette paper, and even force their way through the thick tires of a cart-wheel. Even field entrenchments and also field redoubts do not protect one from "coal-boxes" and projectiles from mortars. Anyone who knows anything at all about it, would simply smile at the bare idea of a light battery engaging heavy artillery for several days, and then defeating it.

And again, the target for field artillery is more the enemy's infantry, machine-guns, and field artillery and not heavy metal. Again, by surprise action, having approached unnoticed, till discovered by hostile aeroplanes and scouts, or from a flank, a light battery can inflict severe blows with its shell-fire, but it must not let slip the favorable moment for retirement, as when discovered there can be no retreat.

But heavy artillery all the same is very vulnerable and may become the prey of a bold stroke at the time of its taking up a new position, or of a bold bayonet attack at night. Indeed the usual target of heavy artillery is either artillery or only compact masses (buildings or dense columns of the enemy), thin lines of infantry are for it, an unsatisfactory mark; therefore to act against it for preference, infantry is necessary if there are no heavy or mortar batteries available.—From *Russki Invalid* in *Journal of the United Service Institution of India.*

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GERMAN FORTRESSES ON RUSSIAN SOIL

This is no fable, no semi-mythical occurence of the past, but a sad fact. * * It would appear that the most fertile imagination would be unable to change the idea of the existence of a German fortress on Russian soil into actual fact; but it fell to the lot of our troops, as was stated in the paper *North Western Life,* (Minsk, 29th November No. 297) to prove by bitter experience this is a fact, when they were called upon to capture such fortresses as the country mansions of "Shukla" and "Porajhnevo," which lie at a distance of 4 and 5 versts respectively from the town of Vladislav, in our frontier territory of Wirballen. The capture of these fortified posts on Russian ground (opposed to the Russians) was no easy matter. Their reduction occupied five days, from 18th-23rd October.

The fortresses of "Shukla" and "Porajhneva" were constructed by their landlord, a German, though a Russian subject, in order to be able to hold in check with the minimum expenditure of force, considerable Russian forces, and even more than that, with the idea of making this a regular "mouse-trap" for them.

They are erections of a sound and permanent type, built in accordance with all the laws of modern fortification, but owing to our criminal confidence in the Germans and our happy-go-lucky system, no one took any interest in them. Latterly, and very justly, in Russian life the remark has become prevalent that the most dangerous enemy of Russia is not the German outside Russia, but the enemy within our gates.

The following is a general description of the mansion of "Shukla."

This great country-house, owing to its arrangements of rooms and the construction of the walls, with loopholes instead of windows, somewhat in the nature of a German barracks in a fortress, was even provided with special furniture of a type something like officers camp kit.

In front of the house was prepared an immense cleared space extending for about fifteen hundred paces, and adapted, as was afterwards shown, for enfilade fire, and intersected by a series of canals, filled with water, and by artificial depressions running in the direction of the house which drew our troops simply from the habit of making use of such depressions, under the enfilade fire of machine-guns posted in the house.

At three hundred paces from this fortress mansion, a narrow, but fairly deep brook intersected the plain, forming as was afterwards shown, an artificial outlet for the water, and masked by bull-rushes in which were arranged wire entanglements. This brook was formed with the intention of delaying our troops in a known well defined spot, making them form an ideal target.

On the right side of the estate, looking at the frontier, almost alongside the house itself, a park had been laid out, in front of which they had built a thick iron-concrete wall about two arshins across with a high sharp palisade, behind which there were very well made trenches and shelters, which must have been built, according to some of our officers who saw them, a considerable time before they were actually used.

Behind the house there were subterranean passages leading to a dense wood with high trees. On both sides of the house there ran, somewhat obliquely, long stone sheds, with unusually thick walls with loop-holes, and which were evidently meant for some military purpose.

To the right of the country-house "post," there was yet another farm "post" connected even in peace time, with "Shukla" by means of a deep canal—a trench, as if for draining away of water, and in war time very easily adaptable as a means of communication or a fire-trench.

Besides what we have said above, we must point out the fact, the posts Shukla and Porajhneva, thanks to their being situated at a distance of five versts from the town of Vladislav not only kept the town itself under a murderous artillery fire, but also the plain in their front, and the river and high-road, thus preventing us from occupying the town, or moving through it into Germany.

Thus the Germans serve the Kaiser,—and Russia; Russian "Citizenship" is apparently simply an empty word.—From *Russki Invalid* in *Journal of the United Service Institution of India.*

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THE BOSPHORUS AND ITS FORTIFICATIONS

The Bosphorus is 16 nautical miles in length, and on an average 1 to 2 nautical miles in breadth. Its breadth is, in detail, as follows:

At the entrance from the Black Sea, between the Rumelian and Anatolian lighthouses, 2 miles (nautical); between the headlands Rumeli-Kavak, 6½ cables; opposite Bugok-Dere, 2 miles (nautical); opposite Therapia, 7 cables; between Rumeli and Amatoli-Hissar, 4 cables; and at its exit into the Sea of Marmora, opposite Constantinople, 1 mile 2 cables. Its depth varies from 25 to 55 sajkens (175 to 385 feet).

There are, on each side of the channel, several convenient creeks among which may be mentioned Ruyuk Dere, northern Therapia and the Golden Horn on the European side; and Beykoz, opposite Therapia, on the Asiatic side.

The defenses of the Bosphorus stretch from the shores of the Black Sea to Therapia and Beykoz, that is, for 8 miles (nautical). The only fortifications that deserve mention are those most recently constructed or re-constructed. From north to south, there are, on the European shore, the following:

1. Kilios—a stone fort armed with six 6-inch guns.
2. Sari Tash battery with a command of 5 to 9 sajkens (35 to 63 feet); armed with two 9-inch, one 8-inch, and three 6-inch guns.
3. Rumeli-Kavak shore battery, command of 2½ sajkens (17½ feet); armed with two 14-inch, two 11-inch, and five 9-inch guns.
4. Teli-Tabiya—four 6-inch guns.
5. Kirech-Keni—four 6-inch guns.
6. Buyuk-Lunan (not marked on the sketch, but north of Sari-Tash)—two 9-inch, one 8-inch, and three 6-inch guns.

Of the above, only Kirech-Keni and Teli-Tabiya are on high ground, the remainder being on the shore of the strait.

The Asiatic shore has the following fortifications:

1. Elmons—an earth work armed with field guns.
2. Phil-Burnu—command of 10 sajkens (70 feet), armed with three 6-inch guns.
3. Anatoli-Kavak, the most powerful of all, with four 14-inch, five 9-inch, two 8-inch, and one 6-inch gun.
4. Madjhar-Kale—two 11-inch, three 9-inch, five 8-inch, and ten 6-inch guns.

The above gives a total of six 14-inch, four 11-inch, seventeen 9-inch, nine 8-inch, thirty-seven 6-inch guns, not including field guns and light quick-firers. South of the Beykoz creek, there are several old batteries, but these are of no importance.

Up to the present war there were no defenses at the southern end of the Bosphorus, but it is reported that during the last few months, the Turks have been hurriedly fortifying San-Stephano, Kadi-Kiyoi, and Princes Islands, and are arming them with guns taken from their battleships and from Adrianople. But as the construction of shore batteries, capable of dealing with heavy guns, is a lengthy process, and as the mounting of heavy guns requires not only abundant time, but complicated technical appliances and special structures, it is improbable that there will be anything heavier than 6-inch guns in these defenses.

As regards the Bosphorus fortifications, all the batteries are constructed of earth or stone. There are no modern improvements in the shape of armored cupolas or solid concrete structures.

The details given above actually refer to the state of affairs in 1913, but it is known no particular changes have taken place since. It is obvious that the principal objective of a fleet attacking from the Black Sea must be the batteries of Rumeli and Anatoli-Kavak, and of Madjhar-Kale, which are all about 4 to 5 miles (nautical) down the strait. The depth of water in the Black Sea will allow of ships standing in close to the shore, where they would themselves be sheltered from fire, and of bringing indirect fire to bear on the principal fortifications.

The channel is also protected by mines, but owing to the depth and the current (up to 6 nautical miles an hour) these are difficult to lay and especially difficult to replace.—From *Russki Invalid* in *Journal of the United Service Institution of India.*

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THE DARDANELLES OPERATIONS

Despatch from Sir Ian Hamilton

(Concluded)

FRENCH CAPTURE A REDOUBT

"From 25th May onwards the troops had been trying to work up within rushing distance of the enemy's front trenches. On the 25th May the Royal Naval and 42nd Divisions crept 100 yards nearer to the Turks, and on the night of 28-29th May the whole of the British line made a further small advance. On that same night the French Corps Expéditionnaire was successful in capturing a small redoubt on the extreme Turkish left west of the Kereves Dere.

"All Turkish counter-attacks during 29th May were repulsed. On the night of 30th May two of their many assaults effected temporary lodgment. But on both occasions they were driven out again with the bayonet.

"On every subsequent night up to that of the 3rd-4th June assaults were made upon the redoubt and upon our line, but at the end of that period our position remained intact.

"This brings the narrative up to the day of the general attack upon the enemy's front line of trenches which ran from the west of the Kereves Dere in a northerly direction to the sea.

"Taking our line of battle from right to left the troops were deployed in the following order: The Corps Expéditionnaire, the Royal Naval Division, the 42nd (East Lancs) Division, and the 29th Division.

"The length of the front, so far as the British troops were concerned, was rather over 4000 yards, and the total infantry available amounted to 24,000 men, which permitted the General Officer Commanding 8th Army Corps to form a Corps reserve of 7000 men.

"My General Headquarters for the day were at the command post on the peninsula.

"At 8 A.M. on 4th June our heavy artillery opened with a deliberate bombardment, which continued till 10:30 A.M. At 11 A.M. the bombardment recommenced and continued till 11:20 A.M., when a feint attack was made which successfully drew heavy fire from the enemy's guns and rifles. At 11:30 A.M. all our guns opened fire and continued with increasing intensity till noon.

"On the stroke of noon the artillery increased their range, and along the whole line the infantry fixed bayonets and advanced.

"The assault was immediately successful. On the extreme right the French 1st Division carried a line of trench, whilst the French 2nd Division, with the greatest dash and gallantry, captured a strong redoubt called the 'Haricot,' for which they had already had three desperate contests. Only the extreme left of the French was unable to gain any ground, a feature destined to have an unfortunate effect upon the final issue.

DASHING CHARGE OF THE NAVAL BRIGADE

"The 2nd Naval Brigade of the Royal Naval Division rushed forward with great dash; the 'Anson' Battalion captured the southern face of a Turkish redoubt which formed a salient in the enemy's line, the 'Howe' and 'Hood' Battalions captured trenches fronting them, and by 12:15 P.M. the whole Turkish line forming their first objective was in their hands. Their consolidating party went forward at 12:25 P.M.

"The Manchester Brigade of the 42nd Division advanced magnificently. In five minutes the first line of Turkish trenches were captured, and by 12:30 P.M. the Brigade had carried with a rush the line forming their second objective, having made an advance of 600 yards in all. The working parties got to work without incident, and the position here could not possibly have been better.

"On the left the 29th Division met with more difficulty. All along the section of the 88th Brigade the troops jumped out of their trenches at noon and charged across the open at the nearest Turkish trench. In most places the enemy crossed bayonets with our men and inflicted severe loss upon us. But the 88th Brigade was not to be denied. The Worcester Regiment was the first to capture trenches, and the remainder of the 88th Brigade, though at first held up by flanking as well as fronting fire, also pushed on doggedly until they had fairly made good the whole of the Turkish first line.

"Only on the extreme left did we sustain a check. Here the Turkish front trench was so sited as to have escaped damage from our artillery bombardment, and the barbed-wire obstacle was intact. The result was that, though the 14th Sikhs on the right flank pushed on despite losses amounting to three-fourths of their effectives, the center of the Brigade could make no headway. A company of the 6th Gurkhas on the left, skilfully led along the cliffs by its commander, actually forced its way into a Turkish work, but the failure of the rest of the Brigade threatened isolation, and it was as skilfully withdrawn under fire. Reinforcements were therefore sent to the left so that, if possible, a fresh attack might be organized. Meanwhile, on the right of the line, the gains of the morning were being compromised. A very heavy counter-attack had developed against the 'Haricot.'

FRENCH HAVE TO FALL BACK

"The Turks poured in masses of men through prepared communication trenches, and, under cover of accurate shell-fire, were able to recapture that redoubt. The French, forced to fall back, uncovered in doing so the right flank of the Royal Naval Division. Shortly before 1 P.M. the right of the 2nd Naval Brigade had to retire with very heavy loss from the redoubt they had captured, thus exposing in their turn the 'Howe' and 'Hood' Battalions to enfilade, so that they, too, had nothing for it but to retreat across the open under exceedingly heavy machine-gun and musketry fire.

"By 1:30 P.M. the whole of the captured trenches in this section had been lost again, and the Brigade was back in its original position, the 'Collingwood' Battalion, which had gone forward in support, having been practically destroyed.

"The question was now whether this rolling up of the newly captured line from the right would continue until the whole of our gains were wiped out. It looked very like it, for now the enfilade fire of the Turks began

to fall upon the Manchester Brigade of the 42nd Division, which was firmly consolidating the furthest distant line of trenches it had so brilliantly won. After 1:30 P.M. it became increasingly difficult for this gallant Brigade to hold its ground. Heavy casualties occurred; the Brigadier and many other officers were wounded or killed; yet it continued to hold out with the greatest tenacity and grit. Every effort was made to sustain the Brigade in its position. Its right flank was thrown back to make face against the enfilade fire and reinforcements were sent to try to fill the diagonal gap between it and the Royal Naval Division. But ere long it became clear that unless the right of our line could advance again it would be impossible for the Manchesters to maintain the very pronounced salient in which they now found themselves.

"Orders were issued, therefore, that the Royal Naval Division should co-operate with the French Corps in a fresh attack, and reinforcements were desptached to this end. The attack, timed for 3 P.M., was twice postponed at the request of General Gouraud, who finally reported that he would be unable to advance again that day with any prospect of success.

TENACITY OF OUR MEN

"By 6:30 P.M., therefore, the 42nd Division had to be extricated with loss from the second-line Turkish trenches, and had to content themselves with consolidating on the first line which they had captured within five minutes of commencing the attack. Such was the spirit displayed by this Brigade that there was great difficulty in persuading the men to fall back. Had their flanks been covered nothing would have made them loosen their grip.

"No further progress had been found possible in front of the 88th Brigade and Indian Brigade. Attempts were made by their reserve battalions to advance on the right and left flanks respectively, but in both cases heavy fire drove them back.

"At 4 P.M., under support of our artillery, the Royal Fusiliers were able to advance beyond the first line of captured trenches, but the fact that the left flank was held back made the attempt to hold any isolated position in advance inadvisable.

"As the reserves had been largely depleted by the despatch of reinforcements to various parts of the line, and information was to hand of the approach of strong reinforcements of fresh troops to the enemy, orders were issued for the consolidation of the line then held.

"Although we had been forced to abandon so much of the ground gained in the first rush, the net result of the day's operations was considerable—namely, an advance of 200 to 400 yards along the whole of our center, a front of nearly three miles. That the enemy suffered severely was indicated not only by subsequent information, but by the fact of his attempting no counter-attack during the night, except upon the trench captured by the French 1st Division on the extreme right. Here two counter-attacks were repulsed with loss.

"The prisoners taken during the day amounted to 400, including 11 officers; amongst these were five Germans, the remains of a volunteer machine-gun detachment from the *Goeben*. Their commanding officer was killed and the machine-gun destroyed. The majority of these captures were made by the 42nd Division under Major-General W. Douglas.

it a point of honor to feed men, animals, guns, and rifles in the fighting line as regularly as if they were only out for maneuvers on Salisbury Plain.

"I desire, therefore, to record my admiration for the cool courage and unfailing efficiency with which the Royal Navy, the beach personnel, the engineers, and the administrative services have carried out these arduous duties.

AMPHIBIOUS METHODS

"In addition to its normal duties, the Signal Service, under the direction of Lieutenant-Colonel M. G. E. Bowman-Manifold, Director of Army Signals, has provided the connecting link between the Royal Navy and the Army in their combined operations, and has rapidly readjusted itself to amphibious methods. All demands made on it by sudden expansion of the fighting forces, or by the movements of General Headquarters, have been rapidly and effectively met. The working of the telegraphs, telephones, and repair of lines, often under heavy fire, has been beyond praise. Casualties have been unusually high, but the best traditions of the Corps of Royal Engineers have inspired the whole of their work. As an instance, the central telegraph office at Cape Helles (a dug-out) was recently struck by a high-explosive shell. The officer on duty and twelve other ranks were killed or wounded and the office entirely demolished. But No. 72003 Corporal G. A. Walker, Royal Engineers, although much shaken, repaired the damage, collected men, and within 39 minutes reopened communication by apologizing for the incident and by saying he required no assistance.

"The Royal Army Medical Service have had to face unusual and very trying conditions. There are no roads, and the wounded who are unable to walk must be carried from the firing line to the shore. They and their attendants may be shelled on their way to the beaches, at the beaches, on the jetties, and again, though I believe by inadvertence, on their way out in lighters to the hospital ships. Under shell fire it is not as easy as some of the critically disposed seem to imagine to keep all arrangements in apple-pie order. Here I can only express my own opinion that efficiency, method, and even a certain quiet heroism have characterized the evacuations of the many thousands of our wounded.

"In my three Commanders of Corps I have indeed been thrice fortunate.

"General Gouraud brought a great reputation to our help from the battlefields of the Argonne, and in so doing he has added to its lustre. A happy mixture of daring in danger and of calm in crisis, full of energy and resource, he has worked hand in glove with his British comrades in arms, and has earned their affection and respect.

OFFICERS COMMENDED

"Lieutenant-General Sir W. R. Birdwood has been the soul of Anzac. Not for one single day has he ever quitted his post. Cheery and full of human sympathy, he has spent many hours of each twenty-four inspiring the defenders of the front trenches, and if he does not know every soldier in his force, at least every soldier in the force believes he is known to his Chief.

"Lieutenant-General A. G. Hunter Weston possesses a genius for war. I know no more resolute commander. Calls for reinforcements, appeals based on exhaustion or upon imminent counter-attack, are powerless to divert him from his aim. And this aim, in so far as he may be responsible

for it, is worked out with insight, accuracy, and that wisdom which comes from close study in peace combined with long experience in the field.

"In my first despatch I tried to express my indebtedness to Major-General W. P. Braithwaite, and I must now again, however inadequately, place on record the untiring, loyal assistance he has continued to render me ever since.

"The thanks of everyone serving in the peninsula are due to Lieutenant-General Sir John Maxwell. All the resources of Egypt and all of his own remarkable administrative abilities have been ungrudgingly placed at our disposal.

"Finally, if my despatch is in any way to reflect the feelings of the force, I must refer to the shadow cast over the whole of our adventure by the loss of so many of our gallant and true-hearted comrades. Some of them we shall never see again; some have had the mark of the Dardanelles set upon them for life; but others, and, thank God, by far the greater proportion, will be back in due course at the front."

—*United Service Gazette.*

PART PLAYED BY BRITISH FLEET AT TSINGTAU

The following is the first authoritative account which has yet been published of the work done by the British fleet at Tsingtau. It fills in many gaps in our knowledge of the siege and is a document of first class historical importance.

The blockade of Tsingtau was established on August 24, and the landing of the Japanese Army was commenced on September 2, at Lungkow, to the westward of Chefoo, whence a fairly level plain exists to the terrain of the German territory. On September 10, the *Triumph*, then at Weihaiwei, received instructions by wireless to join up with the Japanese Navy forthwith, together with the *Usk* to take part in these operations. The ship at the time was at sea carrying out gunnery practices, and returned at once to Weihaiwei, coaled all night and proceeded on September 11 for Tsingtau, arriving off the Island of Chalientao on the morning of September 12. Off Chalientao was the *Suwo*, Flagship of Vice Admiral Kato, C. in C. of the 2nd Squadron, with the *Yakune*.

A conference of Allied Captains was held on board the Japanese flagship and the system of patrols set out. On the arrival (September 13) of Admiral Tochinai in H.I.J.M.S. *Iwate* with auxiliaries, which included a large repair ship, the *Triumph* and *Usk* were ordered to act under his direct command.

During the blockade of Tsingtau the British ships conformed to the movements of the Japanese ships, taking part in all the operations and being based on Weihaiwei (except in the case of emergency) for coal and supplies. During this time in accordance with orders received from the C. in C., four maxims were prepared to fire vertically and two companies of men trained for defense against aerial attack.

The work for mounting one of the 6-pdrs. was also commenced and sweeping practices carried out.

On September 15 the *Triumph* and *Usk* left to convoy the G.O.C.

and Staff, together with the 24th Regiment from Taku Bar to Laoshan Bay. On September 20 they called at Weihaiwei with transports, which embarked 259 mules, sailing for Laoshan Bay on the 21st, where they were met by a Japanese destroyer which led the British ships into the anchorage through the swept area. The British troops were landed on September 23 in the *Triumph's* and Japanese boats, and the following is a general description of the landing place in Laoshan Bay and arrangements made by the Japanese.

Landing in Laoshan Bay

A broad flat shelving beach with a fair rise and fall of tide and deep water close to, sheltered from the north and west, provided a splendid landing place with plenty of inshore room for parking guns, exercising horses, storing ammunition and fodder, and laying sidings for a light railway. A very fair road (as roads go in China) leads inland to the mountain passes. The first pier to be built was a floating one by the Navy, and this lasted well until heavy seas came in on October 16 and 17, but by this time it had served its purpose. Two pile piers were at this time under construction for landing the heavy howitzers, etc.

Flat bottomed sampans were mostly used for landing, each carrying fifteen to twenty men or six horses, the latter being made to walk ashore when the sampans grounded. Large iron lighters were used for landing the gun carriages, gun stores and railway material, lighters being beached at high water and emptied at low. These same lighters carried the heavy guns, and howitzers, to the big pile piers, and a special vessel fitted with a powerful crane lifted them from the transports into the lighters, whilst a wooden gantry erected at the end of one of the pile piers was the means of landing them, side tracks from the railway being laid up to the pier head. A vast number of Chinese were employed on all kinds of work, carrying stores and laying the railway, and appeared to take to the work with alacrity, as they did in all the operations on which they were engaged on inland.

An Inspiring Scene

The Japanese themselves did the water work and the actual landing. The beach generally presented a most inspiring scene, British and Japanese flags crossed before the Commandant's office, wireless station erected, long trains of ammunition and stores moving off, in one long continuous line, with an occasional howitzer battery interposed; railhead being pushed rapidly along, care being taken as much as possible to avoid crops; whilst the work of pile driving and pier building goes on incessantly, with continual landing of men, horses, and all kinds of material.

Total Number of Guns Landed

The total number of guns believed to have been landed is made up as follows:

Fifty-eight siege guns, including six 28-cm. (the same as used at Port Arthur, and nicknamed "Bottles" on account of their similarity), and six 10-in. guns, remainder heavy howitzers. Thirty-six field guns and eighteen mountain guns. In addition four 4.7-in. and four 6-in. guns which are to be worked by a Naval Brigade of 500 men. At this time the Japanese believed

that these guns would be in position and ready to open fire about the end of October.

After the landing of the troops had been effected, all ships continued to carry out the system of patrols laid down by the C. in C. During the whole of the operations mine sweeping was continually carried out, and at about this period especially in and around Laoshan Harbor.

It was desired to clear an approach to this harbor as soon as possible, to enable an attack in force to be made on it from the sea, as, once secured, it would form a very convenient seaplane base, whilst as an advanced base for forwarding supplies to the Army it presented many advantages on account of its comparative proximity to the firing line, compared with Laoshan Bay. Moreover it is also served with an excellent metal road.

Daily Reconnaissances by Seaplanes

Daily reconnaissances, weather permitting, were made by the Japanese seaplanes. Working from the seaplane mother ship, they continued to bring valuable information throughout the siege. The mother ship was fitted with a couple of derricks for hoisting them in and out. During these reconnaissances they were continually fired at by the German guns, mostly with shrapnel, but were never hit. The Japanese airmen usually carried bombs for dropping on the enemy's positions. By September 27 the area swept was sufficient to warrant an attack being made on Laohsan Harbor from the sea, and accordingly all battleships and certain cruisers were ordered to return to Laoshan Bay. When assembled a conference was held on board the Flagship, and instructions given for the attack ordered for the next day, the general idea being that the 2nd Division (*Suwo*, *Iwami*, *Tango*, *Triumph*) should attack Iltis Fort and adjoining works, whilst the *Tokiwa*, *Yakumo*, and destroyers would cover the landing of a Naval Force in Laoshan Harbor. These operations were timed to synchronize with the advance of the army, to the line of hills, of which Prince Heinrich is the southern extremity or the position of the left wing of the army, whilst the right was to rest on the shore of Kiaochou Bay, and the bombardment of the 2nd Division was intended to cover to some extent this advance.

Bombarding the Forts

On September 28 both divisions proceeded to carry out their respective attacks. As the Battleship Squadron passed Laoshan Harbor, it could be seen that the landing had been effected with but little opposition. At 8:45 A.M. the *Suwo* led the division up to the predetermined bombardment position, ships five cables apart, speed twelve knots, and opened fire at 14,000 yards, each ship opening fire in succession on reaching that range. Owing to the haze and mist both gunlaying and observation of fire were difficult. The *Chitose* had been previously posted off Taikungtao for the purpose of spotting, but during this run did not prove of much assistance. The German forts did not reply and it is probable that they were not ready. Whilst the squadron was steaming away to take up a position for another run, Iltis Fort was observed firing at the troops advancing, and was thereby accurately located by our force.

At 9:35 A.M. the second run was commenced; by this time the light had improved considerably. Shortly after the *Suwo* had opened fire on this run, Fort A replied straddling her with a salvo. Each ship as she turned came under this fire, which was maintained by the fort throughout the

run, and, though in many cases shots came close to the ships no hits were received.

The result of the bombardment could not be accurately determined owing to the great range and the fact that many of the works were hidden from the view of the squadron, but the operation was successful and covered the advance of the infantry to the predetermined line where they entrenched to await the bringing up of the siege guns.

It not being then known for certain what success attended the army advance, the fleet received orders for a further bombardment on the next day in the event of it being required. This time, however, it was intended to carry out a different plan, a slow steady fire being maintained from 7 A.M. till 5 P.M. by the battleships working in pairs (*Okinoshima* and *Mishima* being included to make six).

On September 29 the bombardment was cancelled, however, as news had been received during the night that the troops had effected their lodgement successfully the previous day, capturing an officer and fifty-six men. On October 1 Vice-Admiral Toohinai was orderd to take his squadron to co-operate in southern Korean waters, and accordingly relinquished direct command of the British ships; before leaving he presented a captured field gun and carriage to H.M.S. *Triumph* as a memento of British co-operation in the attack on Laoshan Harbor.

Seaplane Base at Laoshan

By this date the minefield off Laoshan Harbor had been sufficiently cleared to permit of the establishment of a seaplane base on shore, and the work of landing a branch of the light railway and stores had commenced. The recovery of mines was undertaken by a flotilla of trawlers, and torpedo-boats together with steam launches and this was not performed without the loss of two trawlers and several lives, whilst the seaplane ship was badly damaged and had to be beached for temporary repairs before being sent to Sasebo. After these losses, trawlers were not much used as they drew too much water and before the end their use had been abandoned.

The Seaplane Corps and three Henry Farman 100 h.p. seaplanes were in consequence of the damage done to the mother ship, landed at the base already established in Laoshan Harbor and this proved eminently satisfactory.

Landing of the Naval Brigade

At this time, October 3, the Austrian cruiser *Kaiserin Elizabeth* and the German gunboats were annoying the Japanese right flank and supply columns continually by an enfilading fire from Tsanghou Deep in Kiaochou Bay.

To deal with this anticipated fire a Naval Brigade of 500 men with four 6-in. and four 4.7-in. guns had been sent and was established by October 4 on Kushan. This battery later on did good service, and on one occasion hit the *Kaiserin Elizabeth* three times, using indirect fire and driving her out of range to a position whence she could do but little damage to our troops.

A German aeroplane (*Taube*) came out during these days and attacked the Repair Ship (*Kwanto Maru*) dropping two bombs which, however, did not hit.

On October 4 a Japanese seaplane made a reconnaissance and reported

that the *Cormoran* and two other gunboats had disappeared from view; it was concluded that the Germans had sunk them in the harbor as it was known that they had not escaped.

German Aeroplanes and Balloon

At the commencement of the siege the Germans had one observation balloon and two monoplanes.

The balloon was constantly used by the Germans for directing their fire and was the only means, other than the aeroplanes, that the Germans had of seeing over the hills behind which our troops were entrenched and siege guns emplaced. It was constantly fired at by the Japanese, though never hit and it was finally lost on October 7 by being blown away. In its course the balloon passed over the *Chitose* and *Triumph* and was fired at by maxims and rifles, but was at too great a height to be struck, and when last seen it was drifting to the northeast and was never heard of again. Of the aeroplanes, both were damaged by accident during the early part of the operations; but one was repaired and continued to do good service until the end, on one occasion fighting a duel with a Japanese aviator without success. At the fall of Tsingtau it was seen to fly away to Chinese neutral territory.

On the 6th a telegram was exchanged with reference to the number and names of prisoners, which was courteously answered by the Japanese. On this date the *Suwo* and *Triumph* carried out a long range bombardment, but owing to mines having been found in the vicinity of the position used by the ships when bombarding on September 28, and as this area had not yet been thoroughly swept, it was not considered advisable to go inside 15,000 meters of Iltis Hill, and at this range the fire was ineffective; consequently, after a few rounds, the bombardment was stopped. Mines during this period were daily recovered and one taken to the *Chitose* was the subject of examination the results of which will be forwarded by the Naval Attaché to the British Admiralty.

It is known that the Germans laid 296 mines; a plan was obtained after the capitulation.

Bombardment by the Fleet

On October 12 orders were given to the Fleet to bombard on the 13th, the plan being for the *Suwo* to bombard continuously Fort "A," whilst the *Tango* and *Triumph* attacked Iltis Hill alternately.

These orders were subsequently postponed on account of the Emperor having intimated by wireless that he would graciously and humanely permit the non-combatants to leave the beleaguered town, as a consequence of which a flag of truce was sent in on the 13th and details arranged.

The Fleet therefore carried out the usual patrol. On the 14th the bombardment was carried out in accordance with orders given on the 12th. The *Suwo's* ten-inch guns having greater elevation (24 degrees compared with the *Triumph's* 13 degrees) enabled her to fire at Fort "A" keeping out of range.

Fire was opened at 9 A.M. by the *Suwo* at "A" and the *Tango* at Iltis.

Fort "A" replied, but fell short of the *Suwo*. At 9:40 A.M. she switched on to the *Tango*, shells falling all round her and it was a marvel that she got away untouched. She ceased fire and steamed out of range. At 9:46 A.M. the *Triumph* came into action and for half an hour delivered an effective

fire on Iltis Fort. At 10:30 A.M., just after the completion of the bombardment and when about to move away, she was struck by a heavy shell at a range of 14,570 yards just under the main crosstrees, doing considerable damage and splinters, passing through the main control roof, killed one able seaman and very seriously wounded an officer and one marine N.C.O. stationed in this position for range-finding duties.

The fire of the *Suwo*, though appearing effective, did not prevent Fort "A" from replying during the bombardment. The *Tango* and the *Triumph* had ten hits signalled on the enemy's works by the *Akitsushima* which was marking. The Fleets returned to Laoshan Bay after the bombardment and anchored.

German Squadron Reported

It was reported from Tokio that a Japanese station in Formosa had observed a German Squadron steaming in a northerly direction and accordingly the Fleet proceeded to sea to meet it. The weather at this time was very bad. The detailed instructions issued to the Fleet are given below:

ORDERS FOR ALLIED SQUADRON

1. *Suwo*
2. *Iwani*
3. *Tango*
4. *Triumph*

} 1st Division

"Maneuvering speed ten knots. Full speed fifteen knots. *Tango* to join near Tchalientau. During the day the squadron will patrol between R. 3 and M. 3 and during the night between R. 9 and L. 4 going east and west.

"*Mogami* will be day and night twenty miles south of B. 4 on right trunk line.

"*Okinishimi* and *Mishima* leave Laoshan Bay 4 P.M. and patrol five miles east of Kitinean on a line parallel to AL and DL.

"*Saga* leaves at 2 P.M. and goes to position thirty miles from Tchalientau on Ross Island line.

"Lighthouses: Tchalientau will be lit as usual, but if necessary will be put out.

"When enemy is found patrol ships will inform by W/T at once and keep in contact with them.

"Full speed of *Okinoshimi* and *Mishima* is twelve knots. Rear-Admiral Okada with *Tone* and two flotillas (9th and 13th) will go to inner patrol line and attack enemy if necessary.

"*Kwanto, Kumano, Matsuye*, and sweeping flotilla will stay at Laoshan Bay under command of Kumane.

"One of sweeping flotillas will patrol entrance to Laoshan Bay and if enemy appears he is to be attacked.

"Aeroplane Corps will throw bombs on the enemy if case permits."

The Japanese undertook to repair the *Triumph's* mast, but in consequence of the report of the approaching squadron, the mast was only temporarily shored up and the squadron proceeded in the evening. The Fleet anchored off Tchalientau on the 16th, patrolling again at night, and as no further news had been heard of the enemy's squadron, the fleet returned to Laoshan Bay on the morning of the 17th and a permanent repair of the *Triumph's* mast was undertaken.

The "Takachio" Sunk

The night of the 17th was very dark and favorable for torpedo attacks, and this together with the fact that the enemy had no doubt observed the Fleet at sea for the last two nights, decided him to send out S. 90; and she, falling in with the *Takachio* at 1 A.M. fired two torpedoes, sinking the *Takachio*, only one petty officer and two men being saved. The latter ship carried mines, and it is thought that these detonated and the great force of the explosion and the close proximity of the destroyer caused some of the latter's plates to open up, since she was afterwards found on the 20th instant beached on Tower Point 30° S.W. Toni Bay, the crew escaping to the shore and eventually being interned at Nanking. From the time she escaped, until her discovery on shore, extra patrols were put on all night, and special destroyers detailed to search the coast.

On the 20th *No.* 7 British Hospital Ship arrived and was placed at the disposal of the Commander-in-Chief. The bad weather experienced from the 15th to the 17th did great damage to the landing facilities, washing away the Pontoon Pier, and wrecking some fifty sampans and drowning some twenty-five Japanese soldiers. The pile piers stood the buffeting without suffering at all. At this time practically everything of importance had been landed, and the heavy rains rendered the roads impassable and washed large sections of the railway away, hindering the transport of the heavy howitzers and ammunition, the delay in consequence being estimated at from a week to ten days.

By October 27 the Japanese had established a spotting and signalling station on a spur at Prince Heinrich Hill 900 ft. high, situated N. 75 E. 6400 yards from Iltis. This station was used by both Navy and Army for directing the fire and was in connection by telephone with the shore gun positions and the shore wireless stations which latter signalled the results to the ships. It consisted of a strong bomb proof shelter well concealed from the enemy. The view of the enemy's positions obtainable was good. In addition to this aid to the Fleet's shooting, special squarred charts showing the enemy's defenses were issued, and a general outline sketch showing the points of aim. This method of controlling the fire proved simple and effective. The defenses of Tsingtau, in addition to the permanent works, mentioned in the military report on Kiaochou, 1906, with addenda, had been further strengthened, particularly against land attack by:

1. A continuous barbed wire entanglement and trench stretching right across the peninsula. This was suported by:
2. A chain of five redoubts; these redoubts were situated on the rising ground, between the barbed wire entanglements and the parmanent works on Iltis, Bismarck, and Moltke hills.
3. Numerous batteries of a semipermanent nature had, in addition, been erected in support of the redoubts, mostly in the rising grounds behind.

The defenses' strength lay primarily in these redoubts, which were individually very strong; and, if these could be captured, the fortress must fall.

These redoubts, while differing in detail, were constructed on similar lines and a description of one will suffice.

Description of Redoubt

These were five in number distributed across the peninsula on the under features at a distance of from 1000 to 2000 yards in front of the main features

(i.e. Iltis-Bismarck-Moltke hills). They were of a permanent nature and formed the main defensive position of Tsingtau.

From the valley and river bed a gradual upward slope cleared of all obstacles formed the glacis and was difficult to recognize as such.

At the crest of the glacis there was an abrupt fall of about 15 ft. which had been faced with a stone wall and whitewashed.

At intervals of about 250 yds. along this wall were lookout Martello Towers of which about 1 ft. was visible over the crest of the glacis. Many of these were difficult to locate from the attacking side.

On the forward slope of this glacis low wire entanglement had been placed and in some places chipped glass.

From the foot of the above mentioned wall the further upward slope formed a second glacis and at the foot of the wall were high wire entanglements 15 ft. in width.

The second glacis was also faced by a wall in the same manner as the first with a similar line of wire entanglements at the foot of the wall.

The continued upward slope formed the third glacis at the crest of which was the parapet of a reinforced concrete infantry fire position, traversed every ten yards and with a back wall also of reinforced concrete. There was no permanent head cover, but this was obtained by either sand bag loopholes or movable shingle box loopholes.

The field of fire from this trench swept all three glacis and the wire entanglements.

The first glacis and wall were continuous right across the peninsula, whereas the second and third glacis circled round according to the contour of the ground, thus forming separate redoubts.

These redoubts were connected with each other by trenches similar to the one previously described with a field of fire sweeping the ground in between the redoubts.

The flanks and angles of the redoubts and the connecting trenches had emplacements for pom-poms and machine guns enabling one redoubt to support the other by enfilade fire.

A cutting from angles in the fire trench led down and behind into the casemetes of the redoubts.

Each redoubt was approached from the rear by a good metalled road and communicating trenches led back to gun positions and to the cover of the woods and under features in rear.

The Final Bombardment

A half battalion of the 36th Sikhs arrived from Tientsin, and were landed on October 22. On the 26th the siege guns were being rapidly completed and communication trenches were being pushed forward by night and also artillery concrete positions, and, to assist in keeping down the enemy's artillery fire, the ships of the Fleet bombarded certain of the enemy's positions during the day.

On the 29th instant, the bombardment of the Fleet was increased in intensity and was kept up practically all day. Ships were listed some five degrees, being thus enabled to keep out of range of Fort "A," the only permanent work which could get at them in the line of approach adopted. The principal positions which could be reached by the guns of the Fleet were Fort "A," and all works on or near Iltis Hill.

In addition, Forts "A" and "C" and the Dockyard could be reached from behind the Haihsi Peninsula, but at this time the area had not been swept clear of mines.

Gradual Advance of Army

During the night of the 30th, the whole line of the Allied army was advancing to the artillery covering positions trenches, roughly 1300 yards from the enemy's first barbed wire entanglement. (The right of the Allied army lay in Syfang, then through Shuangschan, Tungwutschiatsun, Tientschantsun, Hsienyan, to Hsintschiatschan.)

The fleet continued the bombardment of the enemy's positions. During all these bombardments Fort "A" replied at times, but invariably went short.

During the night of the 31st the Army worked up to the first attack parallel and dug it. The army siege guns opened first at daylight and a very heavy fire on all the enemy's positions was kept up by both the siege guns and the fleet all day. During this time the signal station was used.

On November 1 a general bombardment by land and sea was continued. The Governor was called upon in the name of humanity to surrender, but no reply was received. It was thought at this time that the *Kaiserin Elizabeth* might try to escape and accordingly the *Suwo* and the *Triumph* patrolled off the entrance during the night.

During the night of the 1st the Army occupied the first attack parallel and started communication trenches forward to the 2nd attack parallel.

The weather on November 2 was too misty to fire from the sea. Our position was maintained on shore. During the night the army advanced still further and dug the 2nd attack parallel, the right wing occupying the Pumping Station, (this was an attempt which failed, the Pumping Station being taken on the night of the 4th), and the left wing advancing to within 1000 meters of one of the redoubts.

Destruction of Floating Dock

On November 3 it was reported that the *Kaiserin Elizabeth* had been blown up and had sunk off Chitosan, and this was later confirmed. Owing to the proximity of the attacking troops to the redoubt, it was considered no longer safe for the ships to fire at the low-lying works. Portions of the Dockyard were burned and the large crane destroyed, the Floating Dock also careened and sank.

On November 4 the 28-cm. guns opened on Fort "A," whilst other positions were bombarded, particularly the redoubts, by the siege guns. During the 4th, 5th, and 6th the bombardment continued from the siege guns and also by the *Tango*, *Okinoshima*, and *Mishima*, from behind the Haihsi Peninsula. During the night of the 5th, Fort "C" was destroyed by the Germans without ever having fired a shot at the ships. The Army sapped up to the crest of the first glacis.

On the night of the 4th the Army sapped towards the 3rd attack parallel and on the 5th dug the 3rd attack parallel on the crest of the first glacis, this parallel being occupied on the night of November 6. During this night Officers' Patrols entered the 3rd and 4th redoubts, No. 3 being captured, No. 4 blown up, and just before dawn No. 2 fell and white flags were flying everywhere by 7:00 A. M., November 7.

Reported Casualties

Germans 600 to 1000; Japanese 300 killed, 900 wounded; British 52, and Indian 13.

During the night and early morning of the 6th and 7th a tremendous bombardment took place and was supported by shrapnel up to the last, a general assault was made on the redoubts, which fell in quick succession. The Germans did not wait for the bayonet but evacuated the redoubts, losing heavily as they retreated without cover up the slopes of the hills behind.

At the time of writing the casualties on either side had not been officially announced, and as the fortress was not entered by the writers no certain details of damage done to the enemy's positions or their contents and construction can be given. But it was reported that some of the guns on Fort Iltis had been completely demolished. Certain guns and howitzers on Bismarck Hill had also been actually struck and then further disabled by the Germans themselves. The parapet of the redoubts had been blasted away by high explosive shell, both men, rifles and machine guns being completely destroyed.

Number of Rounds Fired

The following is a record of the rounds fired by the squadron during the five days' bombardment prior to the fall of Tsingtau: 12-inch, 180; 10-inch, 408; 8-inch, 107; and 7.5-inch, 120.

Total number of hits signalled, 150.

Hits were on works being attacked and not necessarily on guns. Guns reported demolished: Five on Iltis Hill and one on slope. On four other occasions trenches were reported to be badly damaged.

List of Ships which Took Part

Battleships: *Suwo, Iwami, Tango, Okinoshima, Mishima, Triumph.*

Armored cruisers: *Iwate,* Flag, *Tokiwa, Yakumo.*

Light cruisers: *Chitose,* Flag, *Akashi, Akitoushima, Ghiveda, Takachio.*

Flotilla cruisers: *Tone,* Flag, *Megami, Yedo.*

Gunboats: *Ugi, Saga.*

Late *Pebiedo,* Flag, late *Orel,* late *Poltawa,* late *Ad'Aperaxin,* late *Ad'Senyavia.*

Destroyer depot ship: *Kumano Maru.*

Repair ship: *Kwanto Maru.*

Seaplane ship: Hospital ship, surveying ship, 8 mine sweeping trawlers.

Destroyers: *Usk* and 15 Japanese.

Torpedo boats: 12. —*North China Herald.**

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RETROSPECT OF THE YEAR 1915

The World War

A cursory view of the military situation in Europe, as seen from the outside of the so-called "iron ring" which the Allies have attempted to

* Furnished for publication through the courtesy of the War College Division, General Staff.

maintain around the Central Powers, would seem to justify the assertion of the Imperial Chancellor, Von Hollweg, that Germany is everywhere victorious. She holds Belgium and one of the richest sections of France in the west; Poland is hers; and, recently, with the aid of Bulgaria, she has overrun Serbia and opened up rail connection with Constantinople.

The question of German success, however, is indissolubly bound up with the question of German aims, and, thanks to the explicit teachings of her military writers, we know exactly what the military aims of Germany were, when the Kaiser let loose the dogs of war in the Summer of 1914. A swift drive in overwhelming force upon Paris; the occupation of the French capital; an army of occupation in France; a rapid transfer of the flower of the army to the Eastern frontier, and a furious campaign by overwhelming forces against Russia, for the purpose of breaking up, capturing, and dispersing the Russian hosts, preparatory to the occupation of Warsaw and Petrograd.

The German plan, magnificent in conception, failed utterly when the allied forces under General Joffre turned furiously upon the invaders and threw them back at the battle of the Marne. In the east the Austrian armies were overwhelmed by the Russian hosts. The close of 1914 found the German army held fast in France, and the victorious Russians in possession of Galicia, and making ready to pour down through the Carpathian passes into the plains of Hungary.

In the early Spring of 1915, Germany, taking over the supreme control of the Austrian troops, broke through the Russian lines on the Donajec, and commenced that great drive, which must go down into history as one of the most stupendious military exploits of all time. Brilliant as these operations have been, there is a consensus of military opinion that they have been inconclusive. The Russian army is to-day despite its reverses unbroken; its losses have been enormous; but although it has bent it has never been broken. The Central Powers have failed to disperse and disarm the armies of the Czar, which under the spell of rest afforded by the rigor of the Russian winter, are being re-enforced and munitioned for the spring campaign.

Judged, therefore, solely by the test of what Germany set out to do, it must be confessed that she has failed. The German lines in France are holding, it is true; but the Anglo-French drive in September gave every reason to believe that when another million of the British troops has been thrown into France and the requisite supplies of ammunition have been stored back of the allied position, it will be found possible to break through the German line on a front wide enough to cause a retirement of the whole front to new positions. Failing that, the war on the western front must settle down to one of attrition, and judging by the acknowledged Prussian losses to date of 2,250,000 men, and the monthly losses on all fronts estimated by the best military authorities at 300,000, the decisive issue must surely come before the close of 1917.

The outstanding fact of the naval operations has been the remarkable success of the British defensive against the German submarine raid on merchant shipping. The means adopted have been many and all appear to have been more or less successful. The narrow channels have been netted, and great success has attended the towing of large nets between pairs of destroyers and trawlers. The swift destroyers have accounted for many, and a vast fleet of fast motor boats, some of them private craft

and others built specially for submarine chasing, acting in concert with the aeroplanes, has proved a veritable terror to the under-sea craft.

Since their disastrous running fight with the British battle cruisers, the Germans have remained in port, so far as the North Sea is concerned. The British battleship fleet at its station in the Forth of Firth, awaits the long-deferred coming out of the German fleet, while its scouts, destroyers, and submarines scour the North Sea to give early tidings of the challenge, should it ever come.

The various naval engagements have emphasized the supreme value of speed. Great Britain has completed the five 25-knot battleships of the Queen Elizabeth class. Since the war opened, by the way, she has added twelve dreadnoughts to her active fleet. Also, she has just about completed five new battle-cruisers of the largest size and the unprecedented speed of 32 knots. Her destroyer fleet, moreover, has been increased by the addition of over 70 destroyers of 35 to 37 knots' speed. It begins to look as though nothing short of a miracle could break the strangle hold of the fleet upon the naval situation; and in the opinion of the naval and military critics it is believed that this may prove to be the decisive factor in a war which seems destined to settle down into one of naval, military, and economic endurance.

Aeronautics

In reviewing the progress of aeronautics for the year that has just drawn to a close, the one fact that stands out from all the rest is the predominating influence of the war. Achievements in general have been more of the nature of substantial engineering advancement than of sensational flights and records such as have characterized former years.

Gigantic aeroplanes have been developed by the fighting nations in an endeavor to secure the command of the air. Biplanes and triplanes of over 100-foot spread are either built or are building, while machines of more modest dimensions, equipped with two or three power plants, have made their appearance on the field of battle. Such aircraft are equipped with one or more rapid firing guns of 1½- to 3-inch caliber, as well as several machine guns. In some of the larger machines the crew numbers six or more, while the amount of fuel, provisions, bombs and ammunition carried exceeds the expectations of the most far-sighted aeronautical constructor of antebellum days.

The demand for bigger machines has naturally reacted on engine construction, with the result that more powerful aeronautical power plants have been built of late. As in the instance of the motor car, the twelve cylinder aeronautical engine is hailed as the final word in heavier-than-air craft propulsion. Motors of this type are being made in sizes ranging from 100 to 250 horse-power. The rotary engine, which dominated the field previous to the past year, is being largely replaced by the stationary cylinder types, due to the fact that the latter have been found more simple, easier to repair and of greater reliability, especially in their improved forms. There has been evinced a sustained effort on the part of the engine builders to follow automobile practice in the design of airship power plants.

The equipment of military aeroplanes has been greatly improved and numerous refinements made in the smaller details of construction. Some of the fighting aeroplanes, particularly the German machines, have proved luxurious in the matter of equipment.

The high rate of depreciation of military aeroplanes has given aeroplane manufacturing a tremendious impetus. Crude methods and equipment of former days have been replaced by labor-saving machines and efficient systems, made possible by quantity production. Particularly in America has this change been most conspicuous, one plant at least being now placed on a basis comparable to that of the smaller automobile shops.

The military efficiency of aeroplanes has been greatly raised during 1915. Aerial raids of unprecedented magnitude have been successfully undertaken. Considerable damage has resulted from some of the raids. On the other hand, dirigibles have failed to prove of military value, although participating in numerous forays.

The transparent aeroplane has, it is reported, made its appearance on the French front, but official confirmation is lacking. However, it is known for a certainty that both the French and Germans have been hard at work developing transparent plane surfaces with more or less success.

The development of anti-aircraft artillery has reached a point where it is decidedly uncomfortable for an aviator to fly at an altitude lower than 10,000 feet. Previous to 1915 the average range of aerial artillery was below 5000 or 6000 feet.

Most remarkable of all is the fact that no international records appear to have been broken, while, on the other hand, several new American records have been made. Among these are: DURATION.—Aviator alone, Lt. Byron Q. Jones, U. S. A., January 15, 8 hours, 53 minutes; aviator and two passengers, Lt. Byron Q. Jones, U. S. A., March 12, 7 hours, 5 minutes. ALTITUDE.—Aviator and one passenger, Lt. J. E. Carberry, U. S. A., January 5, 11,690 feet; aviator and two passengers, R. V. Morris, August 10, 8,024 feet; aviator and three passengers, August 10, 8105 feet. DISTANCE FOR HYDRO-AEROPANES.—Aviator and one passenger, Lawrence B. Sperry, January 20, 60 miles. DURATION FOR HYDRO-AEROPLANES.—Aviator and one passenger, Lawrence B. Sperry, January 20, 1 hour, 25 minutes. ALTITUDE FOR HYDRO-AEROPLANES.—Aviator alone, Lt. P. N. L. Bellinger, U. S. N., April 23, 10,000 feet; aviator and one passenger, Lt. H. Ter Poorten, August 31, 8330 feet.—*Scientific American.*

Short Notes*

Yamashiro Launched.—The Japanese battleship *Yamashiro*, a sister ship of the *Fuso*, was launched at Yokosuka November 3. She is the second of four ships of the *Fuso* class to be launched. Construction was begun November 20, 1913, and it is expected she will be completed next year. She will have a displacement of 30,600 tons, a length of 673 feet, and will mount twelve 14-inch guns and sixteen 6-inch guns.—*Shipping Illustrated.*

New Ships Laid Down.—The Japanese battleship *Ise* was laid down at the Kawasaki yard on the 5th of May, and the *Hyuga* at the Mitsu Bishi yard on the 11th, while a third, the *Yamashiro*, is to be built at Yokohama. Nothing has been published concerning these ships beyond their displacement (30,000 tons). Four destroyers of about 1000 tons are to be built (including the *Urakaze* and *Kawakazi*, building in England), four smaller

* From *Proceedings of the U. S. Naval Institute* excepting the last three on page 136.

destroyers, and two submarines of 700 tons. The new construction now in hand and provided for is estimated to cost £2,333,332 in 1915-16, £3,604,-849 in 1916-17, £2,681,864 in 1917-18, and £636,047 in 1918-19.

—*United Service Magazine.*

Vessels Building in Japan.—

Name	Displacement	Speed	Armament	Builders	Remarks
Battleships					
Fuso	31,300	22.5	12 14-in., 16 6-in.	Kure	Launched March 28, 1914
Ise	31,300	22.5	....	Kawasaki	Laid down May 5, 1915
Hyuga	31,300	22.5	....	Mitsubishi	Laid down May 11, 1915
Yamashiro	31,300	22.5	....	Yokosuka	Launched Nov. 3, 1915
Battle Cruisers					
Hiyei	27,500	27	8 14-in., 16 6-in., 8 t. t.	Yokosuka	Commiss'd March 31, 1914
Haruna	27,500	27	same	Nagasaki	Launched Dec. 14, 1913
Kirishima	27,500	27	same	Kobe	Launched Nov. 30, 1913

NOTE:—Japan has two destroyers and two submarines under construction in England and France respectively.

Submarine Building in Japan.—A contract to build a submarine for Italy was signed recently by the Kawasaki Dockyards Co., of Kobe, Japan. The boat will be of the *Laurente* type, and will displace 700 tons when on the surface and 1070 tons when submerged. The length is 250 feet. The boat carries five torpedo tubes, three in the bow and two in the stern, besides anti-aircraft submersible guns and other up-to-date appliances. Her steaming radius is 6000 miles. The hull will be built at the Kawasaki dockyards. The machinery and engines are to be built and sent from Italy. The Kawasaki dockyards have obtained the right to build all future engines and machinery if they so desire in Japan. All the plans and details with the rights are to be furnished them.—*Nautical Gazette.*

Importance of Super-Dreadnoughts.—The *Jiji* says that after the lessons taught by the Russo-Japanese War no naval power is worth the name without a main fleet of super-dreadnoughts to stand in the first line of battle. It points out that both the Saionji and Yamamoto cabinets prepared a program based on the principle of eight ships of the super-dreadnought type to constitute the main strength, but that owing to financial considerations the former cabinet had to be satisfied with building three ships of that type. The new program to be presented by the navy is believed to consist of four battleships, besides some light cruisers, the work being spread over a period of five or six years.

The naval authorities are apparently satisfied without carrying out the eight-ship standard at once. This program, when completed, will mean eight super-dreadnoughts (the *Kawachi* excepted) and four battle cruisers of the *Kongo* class. They are to constitute the main strength of the Imperial Navy. This standard the paper points out to be the minimum of the naval demand, and when it is taken into consideration that the United States by 1919 will have 24 super-dreadnoughts, and Germany 25 ships of the same class, the paper believes that the new demand of the navy must be the minimum, against which no reasonable opposition could be made. The

paper also states that it would be impossible for Japan to compete with either Germany or America in the extent of naval construction. For a nation, however, claiming to have a navy up to date, the paper cannot approve any standard lower than that which the authorities are believed to be planning.—*Reuter, Naval and Military Record.*

Rumor of an Unsinkable Battleship.—Submarines and Zeppelins having failed of their purposes, the German Admiralty is now pinning its faith to an unsinkable battleship now building secretly at one of the German naval plants. So far as is permitted us to speak, the plans of this new superdreadnought which is expected to put all battleships of the 1915 or earlier types into the second class, provide for three outer bottoms, the first being eight inches thick, the second four inches thick, and the third or inner bottom one-half inch thick. Between these three skins are spaces of varying dimensions filled with a secret composition which offers no resistance to the explosive powers of shell or torpedo. It is confidently predicted by modern German ordnance experts that no projectile in present use will ever penetrate the inner skin of this ship, as its shattering power will be spent in its action against the non-resisting composition between the first and second skins of the ship.

The non-sinkable battleship is not new in theory, though naval constructors have been very chary of giving the theory practical support. So far as is known, Germany is the first nation to actually begin to build such a type, while our own Navy Department has actually under advisement at the present moment a plan for the building of an unsinkable ship.

If this type of vessel should prove a success, it will mean a revolutionary change in the existing theories of naval ordnance, all guns and shells in present use being based upon the sole idea of great penetration against an object offering tremendous resistance. The unsinkable battleship by offering little or no resistance to the shell or torpedo has the effect of choking its rending force after the explosion has taken place, and before it has penetrated into the actual vitals of the ship. The only effective ordnance against this ship of the future will have to possess longer range, less weight, and higher explosive capacity, while penetrating power will tend to become of secondary value. A little analysis of the law of kinetics might be illuminating to the experts who believe that the only way to fight one force is by offering force of equal or greater resistance to the impact.—*Seven Seas.*

Preventing Fog with Oil.—At the suggestion of the officer in charge of the Branch Hydrographic Office, New Orleans, attention is called to the possible value of oil as a preventive of fog. It is reported that experiments have been made in France with variable success to prevent the fogs in river valleys, the best results beings obtained by employing vegetable oils. This covered the surface with a thin film of oil which kept the air from coming in direct contact with the warmer water and thus hindered the condensation of the water vapor.

It may well be that a ship which has to stop or anchor off a fogbound coast can create a clear zone around her by distributing storm oil for a time.

The Hydrographic office would be glad to hear from those who make the experiment and from any who may already have had experience in this line. Careful note should be made of all the conditions, such as the character of the fog, temperature of air, temperature of sea water at surface,

state of the sea, direction and force of the wind, method of employing oil, kind and amount of oil used, and how much headway, if any, the ship had; then report whether the oil appeared to spread well, how long it was applied, and what effect it had on the fog. [From Hydrographic Bulletin No. 1356, August 25, 1915.]—*Shipping Illustrated.*

Mine Laying by Submarine.—It is reported that the Germans are laying mines from submarines. This is perfectly feasible and is not improbable. The mines are carried one above another in a vertical air-tight chamber within the submarine. When they are to be laid, water is admitted to the chamber and a door in the outer shell of the hull closing the bottom of the chamber is opened. The mines are then released, one by one, through proper appliances. The mine anchor sinks to the bottom and, by suitable mechanism, the anchorage cable is unwound to permit the mine to float at the desired depth below the surface. This method of mine laying is absolutely secret, and therefore is proportionately dangerous to the enemy.
—*Scientific American.*

Navy Will Build a Great Dirigible.—The Navy Department has decided upon the construction of a dirigible of the Zeppelin type and its construction will be begun at the navy yard in Portsmouth, N. H., on December 15. The airship will be 175 feet long, 50 feet in diameter and will cost $30,000. The engineers who will be in charge of the work are of the opinion that it can be completed in about a month.—*Aerial Age Weekly.*

A New Telautograph has been invented by two Swedish engineers, according to a report of the United States Consul General at Stockholm. The new apparatus apparently differs entirely from the fundamental principles of the telautographs now in use, for it can be operated independently of the resistance of the line. It can be connected to either a short or long line without adjustments of any kind; this advantage making it available for use over ordinary telephone lines.—*Scientific American.*

Notices

Owing to the lack of scarlet dyes, it has been necessary to change the cover of the JOURNAL. While the necessity of giving up "Artillery red" is regretted, every effort has been made to secure the best material and it is hoped that the JOURNAL in its new form will be attractive to its readers.

We desire to congratulate the management of the *Field Artillery Journal* on the recent issues.

The reading matter is most interesting and instructive and thoroughly up to date, while the editing is evidently done by a "master."

Beginning with the July-September, 1915, issue, the *Field Artillery Journal* appears quarterly from the press of J. B. Lippincott Company, Philadelphia, Pa., and like all the work of this well known firm everything connected with the publication is most excellent.

JOURNAL SUBSCRIBERS

In the following list, the Coast Defenses are arranged according to their percentages of officers of the Coast Artillery Corps who are subscribers to the JOURNAL OF THE UNITED STATES ARTILLERY. This is a creditable showing, BUT YOU CAN HELP MAKE IT BETTER. WILL YOU NOT DO IT?

Baltimore Chesapeake Bay Galveston Mobile New Bedford New Orleans Portsmouth Tampa	100 per cent.
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As there are large numbers of officers of the Coast Artillery Corps on duty at the Military Academy, the Coast Artillery School, and in Washington, D. C., the percentage at each place who are subscribers is noted in the above table.

BOOK REVIEWS

With the Russian Army. Being the Experiences of a National Guardsman. By Robert R. McCormick, Major First Cavalry, Illinois National Guard. New York City: The Macmillan Company, 66 Fifth Ave. 5½" x 7¾". 306 pp. 33 il. Cloth. 1915. Price, $2.00.

"Having preserved the best remembrances of the last Ambassador, Mr. McCormick, and wishing to give to the United States a new proof of his sympathy, the Grand Duke consents, as a unique exception, to admit your Mr. McCormick on the field of active fighting, but Mr. McCormick must arrive, not as a war correspondent, but as a distinguished foreigner personally known to the Grand Duke. This will give him an exceptionally prominent position, which is refused to others, and at the same time it will not prevent him from sending to America correspondence, which, of course, will have to pass through the censor."

The above telegram received by the Russian Ambassador from his home government and transmitted by him to Major McCormick explains the remarkable opportunity given to an American officer to obtain a knowledge of the Russian Army while at war.

Before entering Russia, Major McCormick spent a short time in England and in France.

In the former country he met and talked with various members of the British cabinet and surprised Mr. Asquith by telling him that in America "the small element known as 'society' was very strongly pro-Ally; that the element of German ancestry, and particularly that of German birth, was naturally pro-German; and that the bulk of the nation was strongly pro-American and was inclined to be critical of all the nations involved in the war."

Mr. Asquith felt very strongly that the course of his government entitled it to the whole-souled support of the American republic against the German military monarchy.

In France, Major McCormick was permitted to visit the town of Arras where he examined the ruins of the Hotel de Ville and of two churches; but, what impressed him the most on his trip to the French front was that while he passed through the greater part of an army of 200,000 men, he did not see over 2000, and also that while the French "seventy-fives" were firing all around him, he did not see any of them, so well were they concealed.

Leaving France, Major McCormick travelled to Petrograd via Athens, Salonica, Nish, Sofia, and Bucharest.

This journey he found most interesting and as he was brought into "direct contact with the peoples and personages of those turbulent states" he gathered valuable information for his chapter on the cause of the war.

He arrived in Petrograd early in April, 1915, and was almost immediately presented to the minister for foreign affairs whom he describes as the leading diplomat of the world, Mr. Sergius Sazonoff.

While Major McCormick realized that Mr. Sazonoff's knowledge of the situation in the countries of Europe would be most complete, the Major was astonished when the minister knew in detail the causes of the Republican landslide in Chicago during a recent mayoralty election.

Then followed a visit to the Emperor of Russia who made the statement that "the war was very sudden and very unexpected."

All of the Major's experiences, however, were not so pleasant for returning from this visit he was obliged, owing to a lack of knowledge of Russian, to lunch on "two kinds of caviar, a cheese sandwich, and a bottle of quars," and this while dressed in civilian full dress, in a railroad restaurant at three o'clock in the afternoon.

Major McCormick was greatly impressed with the Grand Duke Nicholas, the commander-in-chief, and also with General Yanouskevitz, the chief of staff of all the armies of Russia, and from his description of these two men one can understand the excellent control that has apparently been exercised over the enormous Russian forces, both on the advance and on the retreat.

One chapter is devoted to the Rawka battle line and another to a trip through Galicia.

On the Rawka line was seen the Russian method of employing field guns as anti-aircraft weapons. "The wheels rest on a central wooden platform, and, to get the requisite elevation, the trail is let down into a circular excavation cut around the platform." To obtain the exactitude of range necessary for wing shooting, a 'jack-knife' method has been devised indicative of a high state of originalty in the Russian artillery arm."

In Galicia, the towns of Lemberg and Przemysl were visited and also a division on the firing line during an advance against the Austrians.

In Lemberg it was noticed that the railroad station was "far better than any in Chicago" and in Przemysl there was "nothing to show that a siege had taken place."

One chapter is on the "Military History of the War Till the End of April" (1915).

This history is as given to Major McCormick by a staff officer assigned for that purpose, and traces in general terms the advances and retreats of the Russian forces. It begins with the pushing of "two armies, themselves not fully organized, into East Prussia" for the purpose of compelling the Germans to "detach troops from the forces invading France."

At the end the position is described as "like that of two wrestlers, one of whom is on the mat, the other trying for a fall. The Germans in the ratio of about 20 to 13 are striking here and there, trying to find a weak spot in the Russian line."

In the chapter on "The Russian Army" great praise is given, and to explain this, a statement is made of its history to the effect that Russia "has fought the Mongols and the Turks, the Prussians under Frederick the Great, the Napoleonic Empire under the greatest general the world has ever seen, the three allied nations of England, France and Piedmont, the Turks again, and, lastly, the Japanese," and, "as a net result of all these wars Russia holds more territory in Europe and Asia than all the others combined."

Emphasis is placed on the difficulties encountered in the recent campaigns such as lack of railroads, absence of automobile factories, of private concerns for the manufacture of munitions and the consequent shortage of supplies as compared with her enemy.

In general, however, a high grade of intelligence and foresight were shown in preparing for war.

"Russia has developed a system of transportation easy for her to produce which can travel on any kind of roads and can be supplied indefinitely."

"The Russian field artillery is extraordinarily good." "At the outbreak of war it was said to be composed of six thousand pieces." It has "been completely equipped with all the most modern instruments of precision."

"The Russian infantry is equipped and trained to make the most of the Russian temperament and the Russian physique." "The Russian physique is far ahead of any other in Europe."

"The Russian morale is based on bayonet fighting."

"When it comes to intrenching, nothing can be compared to the Russian regiment." "In the Carpathians, I came upon a position which had been occupied only forty hours before." "Along the whole front was a kneeling trench, with perfect overhead cover and loop-holes every two feet."

"The equipment of the Russian soldier is the result of the experience of two hundred years." "It is an extraordinary combination of usefullness and economy."

In reference to the Russian boot, "the leather is as flexible as kid, and the upper part more like the leather we use for gloves." "Unquestionably, it is a better protection against dust, mud, and water than any form of gaiter used in other armies."

"On the march the Russian soldier is fed from the field kitchen,—a huge cauldron in which the national soup or stew is cooked." "This is composed of a ration of meat and grain and potatoes for each man with whatever other vegetables the cook can lay his hands on."

"The Russian regimental officers are very good." The Russian army has the staff principle developed in great detail." "Every where I saw evidence of a high state of military education."

A chapter is taken to describe the Kazaks. Major McCormick went to Russia with the conception "that they dressed in skins, that when they went to war they took their women with them." He learned that "the Kazaks are an hereditary military organization like the Samurai of Japan." They are trained for war from childhood. "They bring to the army more personal military knowledge than the average soldier takes with him when he leaves after three years." They "are a body of soldiers such as exist nowhere else in the world."

Next follows a description of Ossowetz. The Major "arrived at the fortress early one morning before bombarding time and breakfasted in a casemate which a 42-centimeter shell had struck but not penetrated."

This chapter and the one following "Upon Military Fortifications," should be read with care by all military men. They are well written and are of value.

In conclusion, Major McCormick being a military man and a war correspondent has given us a most interesting and instructive book. He has the "courage of his convictions" and has undoubtedly great self confidence whether he is looking through a persicope in a fire beaten zone, chatting with prime ministers, or interviewing the Tsar of all the Russias. Consequently, he states what he saw and also what he believes in a very forcible manner.

The book should be read by both the civilian and the soldier.

Taschenbuch der Kriegsflotten, 1915. By B. Weyer, Kapitanleutnant. Munchen: J. F. Lehmann's Verlag. 4¾" x 7". 566 pp. Numerous sketches, silhouettes, etc. Cloth.

The present issue is divided into four parts.

Part I comprises pp. 6-462. Pages 6-165 are devoted to tables showing name, date of launching as well as commission, displacement, speed, type of armament, torpedo tubes, armor protection, steaming radius, coal capacity, H. P., length, beam, draft, personnel and station of the warships of the different countries. On pp. 166-171 are found tabulated lists showing losses incurred by England, France, Japan, Russia, and Italy from the outbreak of hostilities to the end of May, 1915. Certain tabulated data relating to commercial steamers, having a speed at least 18 knots, belonging to the great naval powers, is found on pp. 172-174. Data relating to commercial steamers taken over by England and France for war purposes since the beginning of the present war, is found on pp. 175-178. These ships have been used as auxiliary cruisers, protecting commercial trade, transportation of troops, as well as for other war purposes. Tonnage, number of propellers, speed, name of ship and line to which same belongs, are given. Pages 179-411 are illustrated by photographic views, side and deck plan sketches of the different classes of warships of all countries. The side and deck plan sketches show the disposition of the armament as well as the armor in color scheme. In addition, the following information is also given: number of guns able to bear ahead and aft as well as broadside, together with the total weight of metal comprising the latter; number and names of ships in each class; tonnage; H. P. and kind of engines; speed; number and caliber of guns; number of torpedo tubes; coal or oil capacity and steaming radius. Silhouettes of the warships of the different navies are found on pp. 414-462.

Part II comprises pp. 464-479. A comprehensive synopsis in tabulated form of the latest ships of the line and battle cruisers as well as deck plans showing arrangement of armament, are shown on pp. 464-469. On pp. 470-479 are found tables showing the number in the various grades as well as the entire total personnel of the great naval powers in 1914; naval budgets from 1906-1914; tabulated data showing total expenses for each year during the past decade as well as population and expense per capita; and the various grades of naval officers, engineers, and medical officers existing in the navies of the different countries.

Part III comprises pp. 480-531. On pp. 480-498 are found tabulated data pertaining to the naval guns of the different countries, such as caliber and length of gun, method of designating them, weight of gun, weight of projectile, muzzle velocity, rate of fire per minute, penetration of Krupp armor at various ranges, and class of vessel on which installed. Data pertaining to naval and coast defense guns constructed by the Krupp, Armstrong, Coventry, Beardmore, Vickers, Schneider, Bethlehem Steel, Skoda-Werke, and Bofors Companies are shown on pp. 499-512. Data relative to Government and private yards belonging to the belligerent powers as well as the United States, such as name of location, name of firm (in case of private yards), number of docks, number of men employed, etc., are found on pp. 513-527. Lists, in tabulated form, giving names of firms and location for manufacturing armor plate, artillery matériel (guns and ammunition), and torpedoes are given on pp. 528-531.

Part IV comprises pp. 532-566. This part is devoted to the usual conversion tables, a calendar for 1915-1916, and alphabetical index of book

followed by an alphabetical index of all the warships mentioned within the book.

It is recognized that the information given relative to the recent type of ships in the fleets of the Allies is correct as far as the information could be obtained, but to a certain extent necessarily incomplete. The same is true, no doubt, as to the exact number and circumstances attending the loss of the ships stated. It is regretted, from the neutral viewpoint, that information relating to the navies of the Central Powers at war, since the beginning of hostilities, has been omitted. The table showing losses as well as that showing steamers of merchant marine taken over for war purposes, has been added in the present issue of the book; while the usual chapter on Naval Interests and the tabular comparative synopsis relating to strength of different navies, have been omitted. The book evidences a complete revision, while the scope of the naval list has been considerably enhanced by the clearly arranged tables.

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Hawkins Electrical Guide No. 9. By Hawkins and Staff. New York: Theo. Audel and Co., 72 Fifth Avenue. 5" x 6½". 457 pp. 848 il. 1915. Flexible leather. Price, $1.00.

This is an elementary study of electricity in so far as it applies to the telephone, telegraph, wireless telegraphy, electric bells, lighting, and street railways. One chapter is devoted to the study of each of these. Practical questions, which are intended to bring out points pertaining to the fundamental principles of construction and operation of the different apparatus connected with the subjects treated, are printed in heavy black type, and the answers which immediately follow are direct, to the point, clear and concise and are comprehensive to either the practical electrician or the student of electricity. In addition to questions and answers, each chapter contains a great deal of practical technical information and valuable description in connection with the subject to which the chapter is devoted.

From the contents of the Electrical Guide may be obtained a good working knowledge of telephony, telegraphy, wireless telegraphy, electric bells, electric lighting, and electric railways, which makes it of value as a book of reference on these subjects.

The book is neatly bound in black leather and has a flexible cover. In the front part is a table of contents giving the subject dealt with in each chapter and the extent to which each subject is covered. A large number of cuts and illustrations help the reader to a clear understanding of the answers and descriptions.

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How to Make a Transformer for Low Pressures. (Second Edition.) By Prof. F. E. Austin, Box 441, Hanover, N. H. 4¾" x 7¼". 17 pp. 4 il. 1915. Price, $0.40.

This book describes the making of a step-down transformer, from 110 to a minimum of 8 volts, for experimental purposes such as operating low pressure tungsten lamps, ringing bells, operating small arc lights, etc. The description is comprehensive, all materials are specified and all calculations

worked out for the transformer described. The book is of value to anyone who desires to build a low pressure transformer.

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The Development of Armor-Piercing Shells. By Carlos de Zafra, M. E., Faculty Lecturer, New York University, 322 West 57th Street, New York. 6" x 9". 25 pp. 31 il. Paper. 1915. Price, 25 cents.

This pamphlet introduces and explains a patent of the author's, No. 863,248, August 13, 1907, for a design of armor-piercing shell with interior spiral ribs intended to strengthen the shell against the torsional stresses arising from its rotation at the time of meeting the armor plate. It is principally valuable for the brief but interesting historical sketch of the development of the modern projectile for rifled guns, illustrated by sketches of many old and intermediate types.

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Women at The Hague. The International Congress of Women and Its Results. By Jane Addams, Emily G. Balch, and Alice Hamilton. New York: The Macmillan Co., 64 Fifth Ave. 5" x 7". 171 pp. Cloth. 1915. Price, 75 cents.

Within the compass of a very small volume, three of the foremost American workers in social and industrial problems give a well-written account of the International Congress of Women which met at The Hague in the Spring of 1915, and their own experience as delegates.

The record of interviews with representatives of the various countries to which delegations were sent to carry the resolutions adopted, are most interesting; conditions at present existing in the continental capitals are touched upon, while the Appendix contains much valuable information which one could wish might be amplified.

If any doubts have arisen as to the purpose of the Congress, the book serves to explain them away.

And although it may be as yet too early to see the results, it is at all events really inspiring to read of the sincerety and self-sacrifice of the hundreds of women who, from warring and peaceful nations alike, gathered together to voice their protest to the belligerent powers against the continuance of the dreadful conflict—as the right of those who must always feel in its greatest bitterness the cost of war.

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Vision of War. By Lincoln Colcord. New York: The Macmillan Co., 66 Fifth Ave. 5" x 7½". 149 pp. Cloth. 1915. Price, $1.25.

A remarkable poem written in blank verse of a very elastic style. Thoughts are expressed in short lines or in stanzas of many lines; the length of the stanzas generally increasing as the development of a specific sentiment proceeds.

Much of it approaches the dignity of the more poetical biblical constructions, containing in places the philosophy of the Book of Proverbs as in the following:

"Ye who think yourselves wise, shall perish through ignorance;
Ye who think yourselves benevolent, shall perish through greed;
Ye who think yourselves strong, shall perish through weakness;
Ye who think yourselves virtuous, shall perish through sin."

In other places it breathes of the beauty of the Psalms as in:

"Who shall define the spirit—who shall set its bounds!
* * * * * * * * * * * *
The spirit, intangible and inconceivable, the only permanence;
Mold and copy of truth, pose of divinity, God Himself revealed;
Passionate, inextinguishable dream;
Promise of everlasting peace and immortality."

The author depicts the physical suffering caused by war in such a vivid manner as to be almost repulsive to the sensitive mind as the following stanzas relative to the débris of the battle field illustrates:

"His stomach had been ripped open by shrapnel, maggots were heaving in the wound."
"A screaming horse dashes athwart the line, dragging his entrails on the ground."

Death is treated as an inevitable eventuality in peace no less than war.

"I do not see where men are anywhere living forever—so we can reckon death out of the question;
Few of them will die without pain—few of them will die without giving sorrow."

The sentiment in regard to the body after death is no less striking.

"Dust to dust—it will help the next year's crop."

In contrast to the above the spiritual growth of those engaged in war is no less forcefully portrayed, the characteristics developed being designated as: strength, courage, nobility, ungrudging service, infinite tenderness and compassion, the generosity of worthy foemen, the purest instincts of friendship and humanity—the brotherhood of man.

Many of the social evils are charged to the decadent influence of peace.

"But I do not see great measure of truth accruing to humanity, through all this peace.
I see on one side, a good many people living in ease and physical freedom which they have not rightly earned;
I see, on the other side, a good many people living in misery and physical bondage, which they have not rightly deserved;
And I see that those peace surfeits, are less worthy than those peace starves."

The effects of the present war in Europe upon social order is pictured in a dream, which in its essential elements is an utopian dream of universal democracy.

Altogether the book is well worth reading and is a substantial contribution to the recent literature on war.

Journal of the United States Artillery

March-April 1916

COAST ARTILLERY SCHOOL PRESS
FORT MONROE, VIRGINIA.

JOURNAL UNITED STATES ARTILLERY
PRIZE ESSAY COMPETITION

Award of 1915

FIRST PRIZE: One hundred dollars to FIRST LIEUTENANT MEADE WILDRICK, COAST ARTILLERY CORPS.

Subject: *Effect upon measures for coast defense of the development of submarine and aerial attack.*

HONORABLE MENTION: CAPTAIN HARRY C. BARNES, COAST ARTILLERY CORPS.

Subject: *Preparations that should be made in peace for quartering and provisioning coast defense garrisons in war.*

COMMITTEE OF AWARD

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Competition of 1916

The JOURNAL U. S. ARTILLERY announces the following for its annual competition.

PRIZES

One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the JOURNAL.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the JOURNAL OF THE UNITED STATES ARTILLERY. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the JOURNAL and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

(f) Copy must be received on, or before, December 31st, 1916. It must be addressed JOURNAL U. S. ARTILLERY and the envelope must bear the notation, "Essay Competition."

Popular Science Monthly.

BATTLE-CRUISER OF THE UNITED STATES NAVY—A 35-KNOT FIGHTING SHIP

LENGTH, OVERALL, 730 FEET; BEAM, 88 FEET; MAXIMUM DRAFT, 30 FEET; DISPLACEMENT, ABOUT 31,000 TONS; HORSEPOWER, 100,000; SPEED, 32-35 KNOTS. ARMOR: AMIDSHIPS, 12 INCHES; ENDS, 4 INCHES. ARMAMENT: MAIN BATTERY, EIGHT 14-INCH; SECONDARY BATTERY, TWENTY 5-INCH. TURBINE-ELECTRIC DRIVE. (SEE PAGE 252.)

// JOURNAL

OF THE

UNITED STATES ARTILLERY

VOL. 45, No. 2 MARCH-APRIL, 1916 WHOLE No. 138

First Prize, Essay Competition of 1915

EFFECT UPON MEASURES FOR COAST DEFENSE OF THE DEVELOPMENT OF SUBMARINE AND AERIAL ATTACK

BY FIRST LIEUTENANT MEADE WILDRICK, COAST ARTILLERY CORPS

Throughout the pages of military history no offensive weapon has ever been developed whose destructive power has not, in due course of time, been nullified by some defensive means. This fact was amply proved in the days of our own Civil War when the *Monitor* defeated the *Merrimac* in that memorable battle in Hampton Roads. History is repeating itself today and we find that Great Britain has evolved a system that not only protects its High Sea Fleet from the attacks of the daring German submarines, but also, to a large extent, guards its vast and worldwide merchant marine. At present our knowledge of the details of this system is meagre and confused, but nevertheless we know some of the defensive measures taken and in the near future this whole system of defense will undoubtedly be common military knowledge. No factor has perhaps changed the military theories commonly held before the present European War to such an extent as the development of the submarine and aircraft of all types. What will be the future forms of these new engines of war we cannot now tell, but we may rest assured that just as the *Monitor* and *Merrimac* were the forerunners of the present dreadnought, so will the submarine and aircraft of today represent but merely the first step in

the development of these fighting machines of the future, which will be far beyond our present powers of imagination.

The problem that faces us today is therefore to make a thorough study of the effect of the development of the submarine and aircraft upon military operations as demonstrated in the present war, and to apply the lessons learned, to the best of our ability, to our own military system and equipment. In the following pages we will therefore take our present system of coast defenses and see to what extent they can be strengthened so as to better withstand any future attack from hostile aircraft and submarines. As the future development of aircraft of all types will probably have a greater effect in modifying our present system of coast defenses than the future development of the submarine, we will consider that question first.

EFFECT OF DEVELOPMENT OF AIRCRAFT UPON MEASURES FOR COAST DEFENSE

There are two types of aircraft that we must be prepared to meet in the future. One is the dirigible or Zeppelin type and the other the familiar aeroplane or hydro-aeroplane. Today the former has not reached such a point in its development as to enable it to fly across either the Atlantic or Pacific Ocean and attack us. Nevertheless in the near future this type will in all probability be developed to such an extent that we will be forced to take defensive measures against it. These measures will doubtless be similar to those described in the following pages for defense against hostile aeroplanes, the only difference being that the amount of overhead and lateral cover would have to be increased. We will therefore only discuss the necessary defensive measures against hostile aeroplanes, as they are at present the only type of aircraft which we must be prepared to meet.

The aeroplane and hydro-aeroplane have proved to be of the greatest value in the present European War both in offensive and defensive operations, and would undoubtedly be used to great advantage by an enemy in attacking our seacoast defenses. Moreover, it would be possible for an enemy to bring large numbers of this type of aircraft on his transports and warships. It is therefore imperative that we take some steps immediately to better protect our seacoast fortifications against this mode of attack, and not wait until it is too late.

The Use of Our Own Aircraft

In discussing the use of our own aircraft in coast defense we will consider only the aeroplane and hydro-aeroplane. The dirigible or Zeppelin type may play an important part in our coast defense system of the future, but today this type has not been sufficiently developed and its great cost would make its use prohibitive. Moreover, at its present stage of development the aeroplane is far superior to the dirigible for our service. Among its many advantages are the following. The aeroplane offers a smaller target when reconnoitering and spotting artillery fire, for in performing this most important duty the machine must fly low and at a slow speed. The aeroplane in combat has the great advantage of being easier to handle and can out-maneuver the dirigible. Another important point that we must consider is the fact that many types of aeroplanes are now manufactured in this country and would be available for our service in case of war, while no efficient dirigible has been developed to date. Stationary balloons and kites have in the past been used on several occasions to good effect, but their future value is doubtful and would hardly warrant their being used to any great extent today.

There are three separate and distinct types of aeroplanes that we must develop for the efficient operation of this service as follows:

1. The scout aeroplane.
2. The combat aeroplane.
3. The artillery spotting and reconnaissance aeroplane.

In the following pages we will discuss in more detail the qualities that each type should possess and also the duties that should be assigned to each. In general, however, the duties which the aeroplanes assigned to our seacoast defenses should be prepared to perform are as follows:

1. To patrol our coasts and to discover the approach of the hostile fleet and transports.
2. To combat hostile aircraft and to prevent the enemy from locating the position and range of our batteries, stations, searchlights, mine fields, storehouses, etc., etc.
3. To observe or spot the fire of our batteries and to bring the center of impact of the shots on the target.
4. To attack hostile submarines and other types of hostile warships and to protect our mine fields.

5. To reconnoiter and to attack hostile artillery and infantry in the land defense of our seacoast fortifications.

THE SCOUT AEROPLANE

We will therefore discuss first the duties of the scout aeroplane and the necessity of establishing an aerial coast patrol in the United States and its outlying possessions. A great deal of interest has been taken in this subject lately and much has been written about it, both by individuals and by the Aero Club of America. One of the many schemes that has been suggested is as follows: That the Atlantic, Gulf, and Pacific coasts of the United States should be divided into forty-four zones for aerial patrolling. To patrol this coast line it will take forty-four aeroplanes, and these, with the radio installations, receiving stations, hangars, and other equipment will cost $400,000. There should be forty-four aeroplanes in reserve. There should be three shifts of aviators, or 132 men, and these with forty-four telegraphers would be able to man the whole system. The central station for each zone should, if possible, be located at some coast defense in that zone. It would probably be impossible to establish this system along our entire coast in time of peace due to the great cost of operation. Nevertheless certain portions of this system should be permanently established immediately, especially along that part of our coast-line lying between Portland, Maine and Norfolk, Virginia, in addition to certain portions of our Pacific coast and outlying possessions. Plans should be prepared in time of peace so that this patrol could be quickly extended over the rest of our coast-line upon the declaration of war.

With such a system, the authorities in Washington would be in continuous communication with the conditions existing along our entire coast-line and in case of war could be warned at what point the enemy intends to strike. This system should be under the command of the coast artillery district commanders in whose districts the aeroplanes operate. The Navy Department should co-operate with the War Department in this coastal reconnaissance, and should patrol the water areas farther out to sea by means of fast scout boats. In this way the approach of the enemy may be discovered a day or even two days before he could attempt to force a landing on our shores. This would give us the opportunity to concentrate portions of our mobile land forces, coast defense

troops, coast defense submarines, etc., at that portion of our coast-line which is threatened. In order to carry out this system to the best advantage, large units of our mobile army should be permanently stationed at strategical points and always held ready to move by rail to the threatened point of attack.

To this force of mobile troops should be attached large mobile howitzers, which will be described later, manned by the Coast Artillery. The enemy will be at the greatest disadvantage when he is landing his troops and we must therefore make the most of our opportunities and be ready to vigorously attack him at this stage of the operations. A repulse or even a short delay to the enemy at this time would be of the most vital importance, and would have the greatest bearing upon the ensuing military operations.

The scout aeroplane is the type best suited to this air patrol of our coast. It should be different from those aeroplanes permanently assigned to our coast defenses, whose duties will be described later, and should fulfill the following requirements. They should have great speed and flying radius, being able to patrol from fifty to one hundred miles from our coast-line. They should carry a pilot and an observer who should be equipped with a strong pair of field glasses. They should carry a radio outfit and maintain communication not only with their shore station but also with the naval patrol boats farther out to sea. They need not be heavily armed, as their duty is similar to an infantry reconnoitering patrol, and is to discover the enemy's fleet and transports and not to attack them. The scout aeroplanes developed in the present war are all biplanes having a variable speed of forty to one hundred miles per hour. They have small planes and carry no armor, depending on their great speed and quick climbing powers to escape. The so-called British "Baby" or "Tabloid" is reported to be the most efficient of this type so far developed.

COMBAT AEROPLANES

The duty of the destroyer or combat aeroplane is to attack the hostile aircraft and prevent the enemy from locating the position and range of our batteries, stations, searchlights, mine fields, storehouses, etc. As one of the greatest uses of hostile aircraft, as shown in this war, is to spot the shots from his warships and land batteries, we must have a sufficient number of combat aeroplanes of our own to prevent the enemy

from using his aeroplanes in this war. It was by means of this system that H.M.S. *Queen Elizabeth* fired over the Gallipoli Peninsula and destroyed the Turkish coast batteries along the Dardanelles.

Another function of our combat aeroplanes is to prevent hostile aircraft from attacking the various elements of our seacoast defenses with aerial bombs. To accomplish the above results, the chief duty of our combat aeroplanes would then be to obtain command of the air in the vicinity of the threatened coast defense, and to maintain it. For this most important duty there should be permanently assigned to each large coast defense in time of peace two combat aeroplanes. As not more than two or three points along either coast would be threatened at any one time, the combat aeroplanes at the other coast defenses and those held in reserve, could be rushed to the coast defenses being attacked. It is necessary that we properly equip our coast defenses with this class of aeroplane during peace as it is an unusual type and would have to be specially built for this duty.

The European War has shown that the only effective way to deal with hostile aircraft is to attack them in the air and not by shooting at them with anti-aircraft guns. The fast scouting tractor biplane has proved a successful type for this purpose on account of its speed and climbing powers. In fighting between aircraft the most effective weapon is the machine gun. There is some difficulty in its use in a tractor and a pusher biplane is now used extensively. Bullets do little structural harm to aeroplanes. The best results are obtained by explosive shells. The Russians have recently used the giant Sikorsky biplanes in aerial combat. These machines are capable of carrying sixteen persons and with this weight-lifting capacity a heavy gun or number of heavy bombs can be carried. The French call their combat aeroplanes "destroyers." They are pushers and have the machine gun mounted in front. They also carry bombs and wireless apparatus and usually fly at about 2000 meters.

It is reported that the German aeroplane production is undergoing complete revolution, the change being made from light to heavier machines. The new type is a giant battle-biplane of improved design and is nearly three times as large as the ordinary machine. It has immense lifting power, being able to carry an unprecedented weight of armor, guns, bombs, wireless apparatus, signal devices, and a large

crew. This type of machine will unquestionably play an important rôle in the warfare of the future and we must follow its development and be prepared to equip our military establishment with it.

There are three methods of attack that our combat aeroplanes must be prepared to use: ramming, dropping bombs, and using a machine gun. Ramming a hostile aircraft means certain destruction to both machines. It is an effective way to destroy a hostile dirigible or aeroplane, but would only be used in an emergency and when such a step is justified. Another form of attack is to drop bombs on a hostile dirigible, but the value of this method of attack on a hostile aeroplane is doubtful due to the small target presented. Bomb dropping can also be used by our combat aeroplane to good effect in attacking hostile war vessels of all types and any important land targets, as hostile siege artillery, massed infantry, etc. This form of attack is still in its infancy and today is not very effective, but it will undoubtedly become more accurate and scientific as developed in the future. We must therefore equip our combat aeroplanes with bomb dropping apparatus and train our aviators to efficiently perform this duty.

In the present war the machine gun has proved to be the best offensive weapon of the combat aeroplane. In the future larger guns will probably be carried as the weight-lifting power of the machines is increased. These guns are usually mounted in the front of the machine so that the gun pointer will have an unobstructed field of fire. For this reason a pusher is better adapted to this service than a tractor, as the revolving blades of the tractor restrict the field of fire. There are two general types of mounts used today: one in which the machine gun is mounted on supports with a limited field of fire; and the other, or Lewis gun, which is held in the hand like a rifle and can be fired in any direction.

The new all steel battle planes recently constructed for the United States Army represent an entirely new design in aeronautical engineering. These machines have recently been tested at Readville, Mass., and proved most efficient. The design is novel and in general is as follows: The machine is a biplane, about sixty-five feet over all in the wings, and owing to its vanadium steel construction it is of exceptional strength. Unlike any other design now in use for gun-bearing aeroplanes, the gun turrets are placed at the ends of the wings. They are, roughly, eight feet long by two and one-

half feet wide, and will hold a rapid fire gun and gun pointer with ease. The great advantage this design gives is that it will allow the gun a vertical arc of fire of more than ninety degrees, while the horizontal arc is well over 200 degrees. The guns are heavy enough to destroy other aeroplanes or dirigibles, and combined with the bomb equipment will make these new United States combat or battle aeroplanes a most efficient engine of war.

From the foregoing discussion, we therefore conclude that our combat aeroplanes should fulfill the following requirements. First, they should be able to "fight." They should have great speed combined with weight lifting power. They should be able to climb quickly, as this would give them a great advantage in maneuvering. They should be as powerfully armed as any machine which they would be called upon to fight. Today for this service they should be armed with machine guns and all vital parts of the machine should be adequately protected by armor. They should be equipped with bomb dropping apparatus, possess great stability, and be easy to handle.

SPOTTING AND RECONNAISSANCE AEROPLANES

The spotting and reconnaissance aeroplane will undoubtedly prove to be one of the most valuable elements in our future system of coast defense. This type of machine can be used to perform many duties the most important of which are the following: To reconnoiter in the vicinity of the coast defense to which assigned and to discover the position, strength, and movements of the enemy. To observe the fire of our batteries and to bring the center of impact of the shots on the target. They can also be used to protect our mine fields and harbors against the operations of hostile submarines. To control our searchlights and to illuminate hostile ships at night. To be used as dispatch carriers, etc. Future fighting will undoubtedly be conducted at greater ranges than at present, due to the increased range of cannon of all types, and the necessity of having spotting aeroplanes will increase accordingly. Moreover, when using our seacoast armament with indirect fire against a hostile land attack, it is absolutely necessary that we have suitable aeroplanes to control this fire. In this case the observer in the aeroplane should be supplied with an accurate military map of the theatre of operations. This map should be divided into

squares by means of which the observer can indicate the location of hostile targets to the battery commander.

The French have developed a type of machine for this duty which they call the "Artillery Spotter." In reconnoitering they fly at about 1000 meters and are armored on the under side against rifle fire. They carry a wireless outfit, and to enable them while observing to fly slowly and climb quickly, variable speed is developed. Two aeroplanes of this type should be permanently assigned to each of our more important coast defenses, in addition to the combat aeroplanes previously described. These machines should be under the command of the coast defense commander.

Skilled observers should be carried by these spotting and reconnaissance aeroplanes who should be familiar with the country over which they operate. This is very important as detailed observations are absolutely necessary and can only be obtained under unfavorable conditions when the observer can devote his entire attention to this important duty. He should also keep in continual communication with headquarters either by wireless or signaling and be prepared to promptly report not only the location, strength, and movements of the enemy's ships or land troops, but also the effect of the fire of our batteries, and thus be able to assist in its control. To aid the observer in accurately recording the military situation, he should be supplied with a special aerial camera. This would enable him to obtain a clear record of the military details, which could be studied carefully at headquarters and would be of inestimable value to the commanding officer in drafting his orders.

Our spotting and reconnaissance aeroplanes should therefore possess the following qualities to permit them to perform their duties efficiently. They should carry a trained observer in addition to the pilot and should be equipped with wireless and signaling apparatus. To enable them to fly near the ground and at a low speed while observing, and also to climb quickly when attacked, variable speed should be required. They should be armored on the under side to protect them from small arm fire. A machine gun might be carried, but on account of the space this would require, it would probably be better to depend on speed for defense. As these machines would be used only in the vicinity of the coast defense to which assigned, it would not be necessary that they have a great

flying radius, but if possible this should be supplied as it would prove a very valuable asset.

Steps should be taken immediately to interest private individuals and the authorities of the various states to form an Aeroplane Reserve Corps. There are a number of types of commercial aeroplanes now manufactured in this country which are suitable for this duty whose services would be invaluable in case of war. Moreover, some of these machines could be armored to protect their vital parts, equipped with the Lewis Machine Gun, and used to good effect as combat aeroplanes. According to reports from the European War the biplane has proved superior to the monoplane for all duties and is today the type of machine in general use. This is an advantage to us as practically all the aeroplanes now manufactured in this country are biplanes. We should therefore strive to perfect such a system that would permit us to concentrate a greater number of aeroplanes than the enemy at the coast defenses being attacked, which would insure to us that most vital advantage "the command of the air."

OTHER USES OF OUR AEROPLANES

Among the other important duties that our aeroplanes should be trained to perform is that of protecting our mine fields and harbors against the activities of submarines and other types of hostile warships. It is reported that the British aeroplanes have been used to great advantage against the German submarines in this way. A submarine when running submerged or lying on the bottom of the sea can be seen by an aerial observer at depths as great as 50 to 75 feet. As soon as a hostile submarine is discovered in this way there are two methods of attack reported to have been used. One is for the aeroplane to drop a mine-bomb on the submarine, which is timed to explode at the desired depth. The other method is for the aeroplane to notify a patrol boat by wireless and to direct this boat to the point at which the hostile submarine lies submerged. The patrol boat then drops a mine overboard and explodes it near the submarine. At night these machines could be used to protect our seacoast defenses and mine fields from hostile attack. They should indicate the position of the enemy's ships by flying over them and discharging Very pistols or illuminating bombs. This would then enable the shore searchlights to locate the hostile

ships and to illuminate them. In foggy weather our aeroplanes could also be used to patrol the mine fields and to attack any hostile ships attempting to drag or otherwise damage the mines. For this purpose air-torpedoes or bombs could be used. The air-torpedo is a new aerial weapon that has only been recently invented but has proved very effective in experimental firing from aeroplanes. The necessity of using our aeroplanes as messengers or dispatch machines would probably not be frequent. Nevertheless it might be necessary to use them in this way, in which case they would be invaluable for quickly sending orders, maps, or other important military information from one point to another.

In conclusion, it is evident that to obtain the maximum efficiency from our coast defenses in case of war it is absolutely necessary that they be properly equipped with the types of aeroplanes described. The value of the aeroplane in performing its many varied and important duties has been clearly demonstrated in the present war. This is only the beginning and the future importance of these machines will undoubtedly be greater as they become more developed. Moreover, the cost of supplying our seacoast defenses with an adequate aerial equipment would not be great. The need of these aeroplanes is no longer a dream but a vital question. It will be suicidal if we do not heed the lessons learned while we yet have the opportunity, and before it is too late to remedy this weakness.

Use of Hostile Aircraft

In the foregoing pages we have discussed at length the duties of the different types of our coast defense aircraft, namely the scout, combat, and spotting and reconnaissance aeroplanes. We will now consider the uses to which the enemy will put his aircraft and the defensive measures we must take. The most important duties that the hostile aeroplanes will be required to perform will be: first, to reconnoiter and discover the location of the various elements of our seacoast defenses; second, to control the fire of the enemy's ships and land batteries upon these defenses. The Allied Fleet has used its aeroplanes and seaplanes to the greatest advantage in bombarding the Turkish coast defenses along the Dardanelles. Bomb-dropping has also been extensively employed in the present war and would undoubtedly be used by all types of hostile aircraft in attacking our seacoast fortifications.

In case of war we must therefore expect to encounter these methods of attack and must immediately prepare our seacoast defenses to meet them.

Necessary Defensive Measures

We will consider the necessary defensive measures under the following heads:

1. Combat aeroplanes.
2. Anti-aircraft guns and searchlights.
3. Concealment.
4. Overhead and lateral cover.
5. Mobility.

COMBAT AEROPLANES

We have already discussed the use of our combat aeroplanes and emphasized their importance. They have proved the best offensive weapon against hostile aircraft and it is imperative that our seacoast defenses be immediately equipped with this type. If, however, due to a lack of these machines, we should lose the command of the air, we would be at a tremendous disadvantage and would have to depend on the other measures of defense for protection.

ANTI-AIRCRAFT GUNS AND SEARCHLIGHTS

Anti-aircraft guns have been used extensively in the present war and have proved to be of considerable value when used against aeroplanes flying low in reconnaissance. For use in the field these guns are mounted on a tripod or specially constructed motor car. The Krupp plant has developed a special gun of this type for coast defense. This gun has a caliber of 4.2 inches and is pivotally mounted on a fixed base. In using their anti-aircraft guns the Germans group them so as to get a volumn of fire to compensate for their inaccuracy. Rifle fire against aeroplanes has proved ineffective but the fire of anti-aircraft guns has proved more serious. However, an aeroplane is comparatively safe when flying at over 6000 feet.

The present weakness of these guns is the difficulty of obtaining correct ranges at high altitudes. It is only a question of time until this problem will be solved and the efficiency of these guns will be greatly increased. At the present time there are several methods used to obtain ranges which in

general are as follows. The original range is found at the gun by means of a self-contained-base range-finder. An observer is stationed well off to the flank of the gun to observe the effect of the fire. He estimates the overs or shorts of the bursts and telephones the corrections to the gun. To assist him in his observations, various types of projectiles are used for the initial shots. The Germans have employed shells for this purpose which upon bursting emit a dense cloud of highly colored smoke. Shells have also been used that open a form of parachute. Both these types present a conspicuous mark for the correction of the following shots. For night firing the shells are supplied with tracers.

The character and destructive power of the shells of the anti-aircraft gun is another problem. For use against dirigibles a special projectile is required, as shrapnel bullets, although they may penetrate the balloon envelope, do little or no harm. Small leakage of gas results from hits of this kind as the gas is not under great pressure and the holes are small. The best type of projectile for this purpose is one that will tear a large hole in the balloon envelope or one that is similar to a grenade and is designed to explode inside the envelope. At the present time, however, it is doubtful if an enemy could employ dirigibles to any great extent against our seacoast defenses, especially in the early stages of a war.

The type of hostile aircraft that our anti-aircraft guns must therefore be prepared to meet is the aeroplane. The future development of the projectile best suited for use against these machines will probably be great, but today shrapnel is the type in general use. The advantage of shrapnel lies in its time fuse and large destructive area. Detonating shells have also been successfully used to disturb the equilibrium of an aeroplane in flight. To assist these guns at night in repelling a hostile air attack our seacoast defenses should be equipped with special searchlights. These lights should be similar to those now installed in our fortifications, but specially mounted so as to be more easily handled in overhead searching. Searchlights of this type have been successfully used in the defense of London and other large cities against nocturnal air raids.

It is apparent that steps should be taken at once to equip our seacoast defenses with this means of aerial defense. The guns and searchlights assigned to this duty should form a separate command. Target practice should be held against

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The Journal of the Royal Artillery.

FIG. 1. KRUPP 28-CM. (11.2-INCH) HOWITZER
SHIFT FROM TRANSPORTING WAGON TO FIRING CARRIAGE

1587

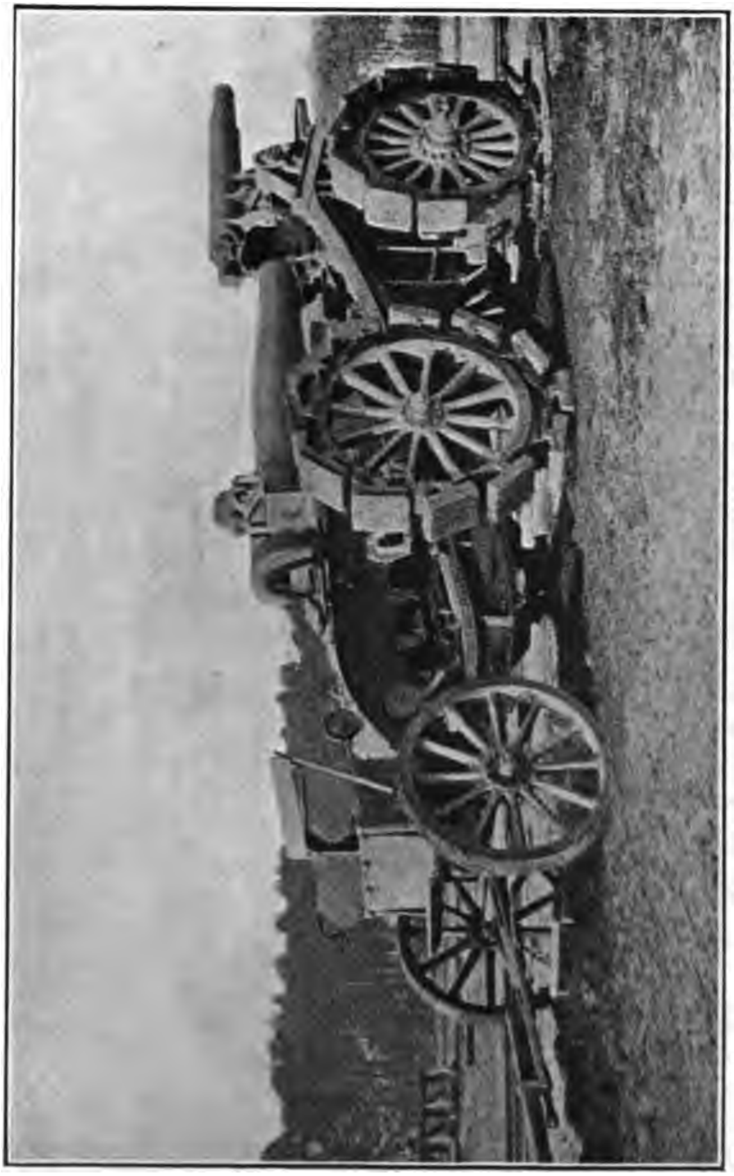
kites and other aerial targets. To obtain the best results, these anti-aircraft guns should be equipped with a complete telephone system of their own and grouped on the extreme flanks of our seacoast defenses with the observers near the center.

CONCEALMENT

The question of concealment is no longer a theoretical doctrine to artillery commanders in the field, but a vitally practical one. In fact it might be termed a religion. According to authentic reports from the battle-fields of Europe this question is considered so important that battery commanders have strict orders never to open fire when there is a hostile aeroplane within sight. The only time that they are permitted to expose the position of their battery in this way is when they are preparing the way for an infantry assault or when the assault is actually under way. Dummy implacements and guns with smoke bombs have been used to help hide the real positions of batteries and to confuse the enemy's artillery fire. Every effort possible has been made to screen all emplacements, observation stations, trenches, magazines, etc., from the eyes of hostile air-scouts. Trees, shrubs, straw and any other available material at hand have been used. It has been learned by bitter experience that as soon as a battery has been located by a hostile aeroplane it is only a question of a few minutes until the position will be swept by a blanket of withering fire.

The value of concealment as a measure of defense as applied to our seacoast armament has two main objects. First, to prevent a hostile air-scout from locating the positions of the various elements of our seacoast defenses and spotting the hostile fire on these elements. Second, to prevent hostile aircraft from attacking the more important elements of our fortifications with aerial bombs.

The solution of the problem of concealment as regards our present system of coast defenses is indeed a difficult one, as they are very vulnerable in this respect. At present our large gun batteries, mortar batteries, etc., are so constructed that it is practically impossible to make them invisible to a hostile air-scout. These objects can be easily seen by a hostile aeroplane at altitudes as high as 4000 feet, at which height it would be comparatively safe from our anti-aircraft guns. It is therefore most important that our batteries, storehouses,



The Journal of the Royal Artillery.

FIG. 1. KRUPP 28-CM. (11.2-INCH) HOWITZER
SHIFT FROM TRANSPORTING WAGON TO FIRING CARRIAGE

1587

etc., should be screened by means of trees, shrubs, vines, etc. To best accomplish this result the ground in the vicinity of our batteries should be planted with pines as these trees do not lose their foliage in winter. The emplacements should also be painted a color that would blend with the surrounding ground. The best solution of this question of concealment lies in making the various elements of our coast defenses mobile. We will discuss this point under the head of mobility.

OVERHEAD AND LATERAL COVER

Another great lesson taught by the present European War is the so-called necessity of "digging in." It has been learned at the greatest sacrifice of life and matériel that no open permanent fortification can long withstand the effect of modern artillery fire. In fact it might almost be said that the whole theory of field fortifications has been completely changed. At no period in military history has trench warfare assumed such an important rôle as in the present war. This unquestionably is largely due to the development of aeroplane control of artillery fire. The question of cover, as applied to our present system of seacoast fortifications, therefore assumes new importance.

There are three methods or combination of methods of attack that our coast defenses must be prepared to meet, which are as follows: first, a naval attack; second, a land attack; third, an aerial attack. The theory upon which our seacoast defenses have been built to date is that they will be required to resist an attack from hostile warships only. With this purpose in mind our batteries and observing stations have been supplied with considerable lateral cover or protection against an attack from the sea. The emplacements for both gun and mortar batteries have therefore only been provided with cover to protect them from the low angle gunfire of hostile ships. No cover whatever has been supplied for protection against high-angle fire, under the assumption that ships cannot use high-angle fire, due to the character of their construction. For this reason we find our seacoast defenses today not only unprotected from high-angle fire of heavy hostile land artillery controlled by aeroplanes, but also from an aerial bomb attack.

The attack of the Allied Fleet on the Turkish coast fortifications along the Dardanelles has again proved the utter futility of attempting to reduce land defenses by means of a

fleet acting alone. This lesson has been learned many times in the past and will probably not be attempted again in the near future. It is therefore certain, in case of war, that our coast defenses will be attacked by land as well as by sea. In this land attack they will undoubtedly be subjected to the fire of large mobile howitzers such as the Germans used so effectively at Liège, Namur, and Antwerp. The enemy will employ aeroplanes in conjunction with these batteries in controlling their fire. After seeing pictures of the crumpled Belgian forts, it requires little imagination to picture what would happen to our seacoast batteries if an enemy should succeed in hitting them with a shell from a howitzer of this type. Moreover, we must expect to be subjected to 12-inch shrapnel fire by the hostile fleet. As a shrapnel of this size would contain about 12,000 to 15,000 balls, it can easily be imagined what a successful burst would do to one of our exposed gun crews.

The danger from aerial bomb attack is not great today. It must be remembered, however, that this method of attack is still in its infancy and there will be great development along this line in the future. In the present war bomb dropping has been extensively used but, due to the difficulties of aiming, no great results have been obtained. The dirigible is superior to the aeroplane for this duty for several reasons. It can remain motionless above the target and the inaccuracy of aiming due to speed can thus be eliminated. In this case, however, it offers a large target to the anti-aircraft guns and would run a great risk of being destroyed at low altitudes. The dirigible is also superior in that it can carry bombs of greater size and destructive power than the aeroplane. It is reported that charges as great as 400 pounds of nitro-gelatin have been dropped from an aeroplane. A bomb containing this amount of high explosive, if successfully dropped on one of our seacoast emplacements, would literally blow it to pieces. As the lifting powers of aeroplanes increase, the size of bombs carried will increase accordingly, and this form of attack will no doubt prove a serious problem as developed in future wars.

The moral effect on our troops, caused by the bursting of the high explosive shell, large shrapnel, and bombs previously described, must be considered almost as much as their destructive effect upon the matériel of our seacoast defenses. In the excitement of the firing at our annual target practice it is hard enough to prevent errors in range setting. How much

greater will be the chance for these errors in actual combat if the men serving the guns are not properly protected against shrapnel and flying bits of shell and concrete? It is therefore apparent that we must do something to increase the overhead and lateral cover of the various permanent units of our seacoast defenses. In the following pages we will discuss the different elements of our fortifications separately and see to

Photograph by Boston Photo News Co. 1719

FIG. 2. BOMBARDMENT OF TSING TAU

ALTHOUGH THE FORTS WERE MORE OR LESS CONCEALED AND PROVIDED WITH OVERHEAD AND LATERAL COVER YET, NOT BEING MOBILE, THEY WERE HELPLESS AS SOON AS LARGE HOWITZERS FOUND THEIR RANGE

what extent the question of cover can be applied to each. This problem can be largely solved by making the various elements of our coast defenses mobile. We will consider this question later when discussing the advantages of mobility.

MOBILITY

The value of mobility has been clearly demonstrated in the present European War. It has proved the best means of escaping the destructive effect of hostile artillery fire con-

trolled by aeroplanes. This question of mobility is today considered so important on the battle-fields of Europe that artillery commanders have the strictest orders to immediately move their batteries several hundred yards to either flank whenever, in their opinion, the position of their battery has been discovered by a hostile air-scout. In this case, their orders go on to specify, they must not return to their original positions until the enemy has ceased to shell that position or until they are morally certain that he does not intend to do so. To confuse the fire of the Allied artillery the Germans have prepared three or four emplacements for each of their batteries at widely separated points. As soon as an Allied air-scout locates a battery in one of these emplacements, they immediately move out and take up a new position in one of the other emplacements. This method has proved very effective and we can easily apply this principle to the mobile system of coast defenses which we will discuss later.

The initial success of the Germans and Austrians in the present war was largely due to their forethought in developing their large mobile guns and howitzers before the war broke out. This put the Allied forces at the greatest disadvantage and it was many months before they could procure heavy guns and howitzers of this type and meet the Teutonic troops on equal terms. In case of war today we would find ourselves fighting under the same disadvantages as the Allies did at the beginning of the present war. We should therefore immediately correct this glaring weakness and equip our military establishment with large mobile mortars or howitzers and their necessary complement of spotting aeroplanes. Coast Artillery troops are especially adapted to this service as these large mortars and howitzers will by necessity become a part of our future system of seacoast defenses; and also because both officers and enlisted men of the Coast Artillery are familiar with the problems encountered in serving heavy ordnance.

What will be the future effect of the development of aircraft control of heavy mobile artillery fire upon permanent fortifications we cannot now tell. However, the present indications certainly seem to point toward the necessity of making this armament mobile. Just as the old stone forts built before the Civil War proved unable to cope with the artillery fire of the past fifty years, it looks today as if our permanent fortifications would be unable to with-stand the

aeroplane controlled fire of this new type of heavy mobile artillery and the attack from aerial bombs. This perhaps is a too radical assumption and the best results will probably be attained by making only certain elements of our future seacoast defenses mobile.

In our previous discussion we have seen the difficulties encountered in attempting to make the various fixed elements in our seacoast defenses invisible to hostile air-scouts, due to their size. We have also seen the necessity of providing these same fixed elements with adequate overhead and lateral cover, but here again we encounter not only the problem of

Engineering. 1734

FIG. 3. 6-INCH GUN MOUNTED ON TENDER FRAME AND ENGINE BOGIE
THIS SYSTEM OF MOUNTING HEAVY ARTILLERY IS ESPECIALLY ADAPTED TO THE PROBLEM OF COAST DEFENSE IN THE UNITED STATES, DUE TO OUR COMPLETE SYSTEM OF COAST-LINE RAILROADS

size but also that of expense. It would therefore seem that the easiest solution to the problem would be to make these elements mobile. In this case as soon as an hostile aeroplane located their position and got their range, they could immediately move and take up a new position. At present they have no defense against these new methods of attack and would be forced to remain where they have been permanently installed and weather as best they can the aeroplane controlled storm of hostile shot, shell, and aerial bombs.

In considering the ways and means of equipping our seacoast defenses with heavy mobile artillery, we find there are two general methods of transportation which have proved practical in the present war. One is to transport large guns and howitzers by gasoline tractors over ordinary roads, the other is to mount them on railroad flat-cars so that they can be

fired directly from the railroad track. The problem of making guns over ten inches in caliber mobile is a difficult one, due not only to the weight of the gun itself, but also to the impossibility of taking up such great lateral thrust upon discharge. It would therefore seem that the most practical solution of the problem of mobility, as applied to our future system of coast defense, would be to mount our heavy guns as at present in permanent emplacements, and to make our mortars, heavy howitzers, small guns, searchlights, etc., mobile.

Question of Concealment, Cover, and Mobility as Applied to Our Present System of Coast Defense

From the foregoing discussion we find considerable weakness in the present construction of our coast defenses, due both directly and indirectly to the development of hostile aircraft. These weaknesses can be roughly classed under three general heads as follows: first, lack of proper concealment; second, lack of cover against aeroplane controlled high angle fire, shrapnel fire, and aerial bombs; third, utter lack of mobility. In this connection, however, we must remember that the majority of these defenses were designed and installed about twenty years ago. This was long before the days of aeroplanes, and at the time they were constructed they were undoubtedly able to resist all known methods of attack. Times have changed, however, and we find ourselves today face to face with new problems and conditions. Many great lessons have been learned in the present war, but only at the greatest sacrifice of life and matériel. To keep abreast of the times we must take these lessons to heart, and give them our earnest consideration. In the following pages we will therefore apply the lessons learned, as regards concealment, cover, and mobility, to the various elements of our present seacoast defenses, and see to what extent they can be strengthened. We will consider each separately and in the following order:

1. Stations.
2. Telephone system.
3. Large gun batteries.
4. Mortar batteries.
5. Small gun batteries.
6. Searchlights.
7. Submarine mine system.

STATIONS

Perhaps the most vulnerable element in our coast defense today is the fire control system. This might be called the heart of our whole system and yet a majority of the stations are neither concealed nor provided with adequate cover. Trees, shrubs, vines, etc., should be planted in the vicinity of these stations to make them as invisible as possible to hostile aircraft.

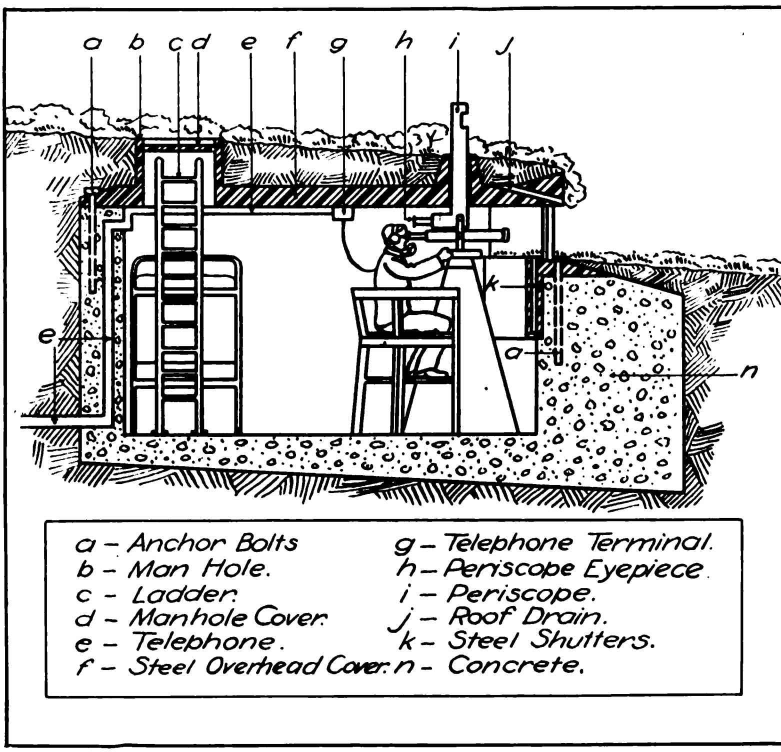


FIG. 4. OBSERVATION STATION 1768

The present method of construction offers no overhead cover and practically no lateral cover against aerial bombs, shrapnel, bits of shell, etc. Moreover, the positions of these stations are probably known today by the military authorities of the other nations, and, in case of hostilities, they would immediately become the target of the activities of hostile aircraft. The question of mobility would not apply to these stations, because accurate plotting would require that the points of observation be fixed. Nevertheless, an auxiliary system of accurate maps should be worked up. This would provide a

mobile fire control system which would prove invaluable in case of emergency. As we cannot make these stations mobile, we must protect them by means of concealment and cover.

It is believed that an observing station similar to that shown in Fig. 4 would fulfill the above requirements. The station should be placed on the side of a slope and sunk well

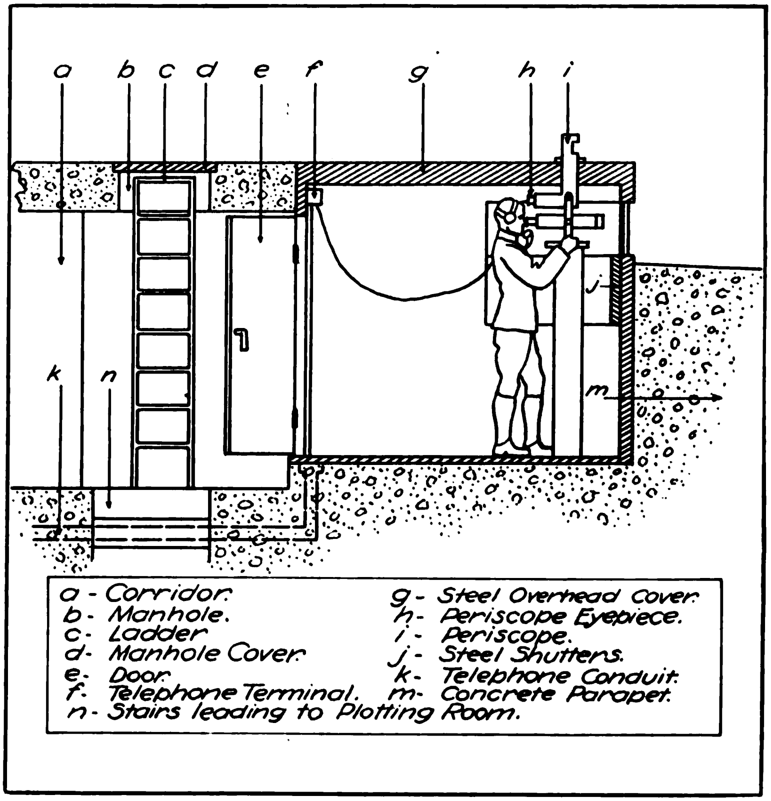


FIG. 5. BATTERY COMMANDER'S STATION 1769

below the surface of the ground. The roof should be of steel and of sufficient thickness to prevent aerial bombs, shrapnel balls, bits of shell, etc., from penetrating it. To provide concealment, grass, bushes, vines, etc., should be grown on the roof. The telephone lines should be sunk well under the ground in conduits, and given all the protection possible. A periscope could be used as shown, and might prove to be of great value in an emergency. In case of war, sleeping accommodations should be provided for two observers.

The present type of battery commander's station has in

general the same weak points, namely, lack of concealment and adequate cover. As the fighting efficiency of the whole battery depends upon the safety and freedom of action of the battery commander, every possible effort should be made to protect him and afford him safe passage to every point in the battery. It is believed that these results would be obtained by moving the station forward into the concrete traverse between the guns, and providing it with steel overhead cover.

A station of this type is represented in Fig. 5. This design would offer the same advantages as the observing station previously described. The plotting room should be located at the battery and protected from all methods of hostile attack. A smaller auxiliary B. C. station, with complete telephone equipment, should be placed on each flank of the battery for use in case of emergency.

TELEPHONE LINES

Continuous communication between the battery and observing stations is an absolute necessity for efficient fire action. To obtain this it has been found necessary in the present war to lay double telephone or buzzer lines at vulnerable points, as a bursting shell will often carry away 50 to 100 feet of the line. To insure this continuous service, it has also been found necessary to construct underground testing stations at intervals along the lines. An operator and assistant are assigned to these stations and it is their duty to test both lines and locate breaks quickly. They are responsible that their section of the lines is always in operation, and, in case of a break in either one of the lines, they immediately repair it. This is a very important point and some such system should be developed to insure the maintenance during combat of the many telephone lines in our present fire control systems.

LARGE GUN BATTERIES

We have already seen the impossibility of making our large gun batteries invisible to hostile aircraft, due to the great size of the emplacements. Nevertheless every possible effort should be made to correct this weakness by planting trees and painting the emplacements a neutral color. We have also considered the difficulty of making guns of over 10 inches in caliber mobile, due to their weight and lateral thrust upon discharge. We therefore come to the conclusion that, as we cannot conceal these guns or make them mobile, we

must provide them with adequate overhead and lateral cover. At present the only cover they have is that offered by the parapet against the direct low angle fire of hostile ships. Against the effect of high angle fire of hostile land batteries, navy shrapnel, and aerial bombs, they have no protection whatever. It is therefore our duty to supply adequate cover against these new methods of hostile attack.

In Fig. 6 is a sketch which is offered as a suggestion to obtain these results. This design embodies most of the advantages of the turret mount without its disadvantages of

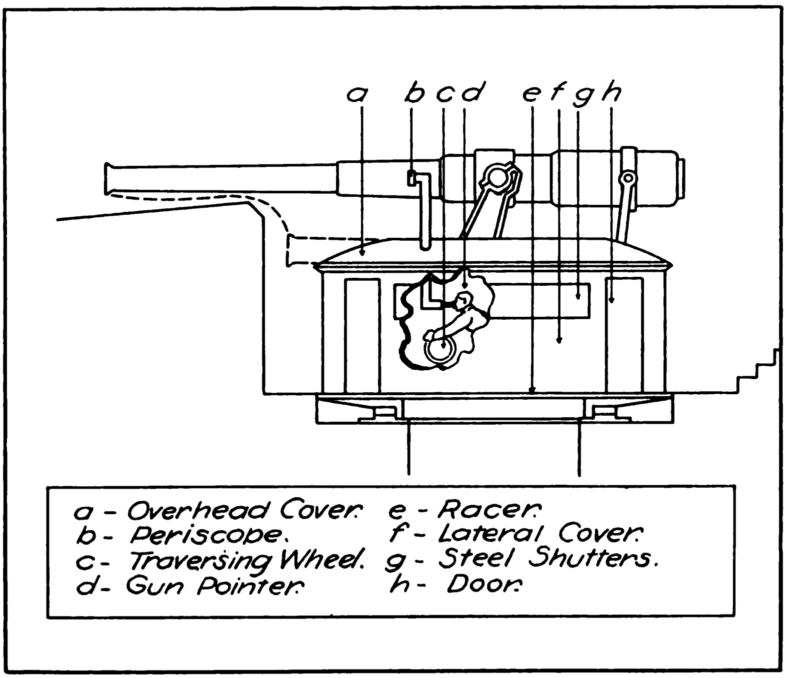


FIG. 6. COVER FOR DISAPPEARING CARRIAGE 1779

cost, weight, and complicated mechanisms. All that it requires is to enclose both sides of the racer with an overhead steel cover and sides, of sufficient thickness to protect the gun details from aerial bombs, shrapnel balls, and flying bits of shell and concrete. It is believed that the moral effect upon the men, feeling that they are adequately protected, would greatly increase the fire efficiency of the battery in actual combat. Of course the loading and breach details would still be exposed. However, they can be more easily spared than the other details and, if necessary, can seek cover between rounds.

Under our present system, the gun-pointer is unduly exposed and it is doubtful if he would long survive in a modern engagement. To correct this weakness the gun should, if possible, be equipped with a periscope as shown. This would not only afford this important member of the gun crew cover, but would also enable him to personally control the traversing of the gun and save much time in getting on the target. If this should not prove practical he could be posted as at present on the sighting platform, but should be protected by means of a steel shield. The advantages of this semi-turret protection are that it can be easily added to the present type of disappearing carriage, at no great cost and without materially changing the present service of the piece.

MORTAR BATTERIES

The question of concealment as applied to our mortar batteries is a difficult one. It might however prove practicable to stretch a canvass cover over the mortar pit, painted the color of the surrounding ground as seen by a hostile air-scout. This cover could be laid on beams or wires stretched across the top of the pit, with grass, hay, twigs, etc., strewn over it. In this way the position of a battery could be kept from the enemy before an engagement. The present method of mounting mortars in pits offers excellent protection or cover against the direct low angle fire of hostile warships. However, against high angle fire of heavy siege guns controlled by hostile aeroplanes, and also against shrapnel and aerial bomb attack, they have no protection whatever. In fact our present method of mounting mortars really increases their vulnerability from the above mentioned methods of attack. A well aimed bomb, or a well timed shrapnel burst would not only annihilate the gun crews, but would also put the battery out of commission. To afford some protection against such an attack, it might prove practical to provide the individual mortars with steel shields. Our present system of mounting mortars could not, however, long withstand the effect of hostile high angle fire, spotted by hostile aeroplane. Similarly, the present type of mortar battery commander's station is weak in concealment and overhead cover, and should be replaced by a station similar to those previously described.

We have seen the difficulty of concealing our mortar batteries and also the impossibility of giving them sufficient cover from this high angle fire of hostile siege guns. The

only other means of defense open to us is, therefore, to make them mobile. This is a most logical conclusion and a very practical one. The importance of mobility has, as we have already noted, been clearly demonstrated by the present war. If we are going to keep up with the times we must immediately add heavy mobile mortars or howitzers to our military establishment, similar to those developed by the Austrians and Germans. The service of these large mobile mortars or howitzers is easily adapted to our present methods of coast defense, and would greatly increase the fighting qualities of our seacoast armament.

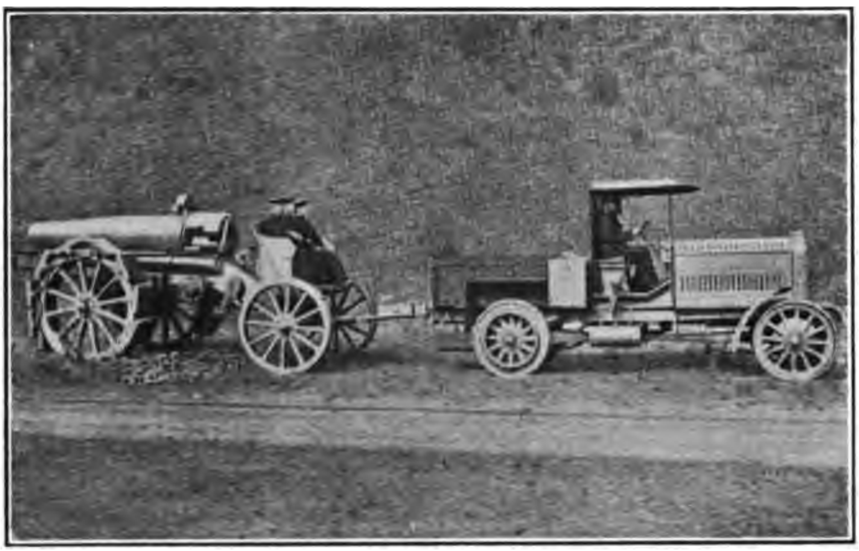
Transportation of Heavy Mobile Artillery by Tractors over Ordinary Roads

One of the solutions to the problem of mobility as applied to heavy ordnance is the use of the gasoline tractor over ordinary roads. The two most efficient weapons of heavy mobile artillery developed in this war are the Krupp 42-centimeter howitzer and the Skoda 30.5-centimeter howitzer, both of which are transported in this manner. As the Skoda howitzer* offers a good example of what our future seacoast mortars ought to be, we will consider it more in detail. The Skoda howitzer was developed by the Austrians before the war broke out, and it is to them that the reduction of the Belgian forts and those at Przemysl is largely due. They have proved very accurate and their shells have terrific effect both against fortifications and troops in the field. They fire a shell weighing 860 pounds with a muzzle velocity of 1115 f.s., the maximum range being 14,000 yards. They are very mobile, can be mounted in 24 minutes, and entirely dismounted and removed in 40 minutes. This permits them to quickly take up a new position when discovered by hostile aircraft, and also offers little chance of capture. They are transported in sections on tractors at the rate of 12 miles an hour. They are drawn by a Skoda-Daimler motor-car of 100 h.p., with four driving wheels, and at low speed can go up a 16 per cent grade.

Let us assume that we had a mobile howitzer or mortar of this type to supplement our present seacoast armament. These howitzers or mortars could not only be used against hostile ships, employing the same fire control system as is used by our present seacoast mortars, but could also be used

* See pages 3 and 4, JOURNAL U. S. ARTILLERY for January-February, 1916.—Ed.

against hostile land targets, either in the land defense of our seacoast fortifications, or when serving with the mobile army. For use against hostile ships, they should be supplied with armor-piercing shell, and for use against land targets they should be supplied with shrapnel. As suggested in the first part of this article, these weapons should be assigned to duty with the mobile army, in assisting to repel a hostile landing on our shores. Assuming their maximum range as ten miles, they could attack the hostile warships covering this landing,



The Journal of the Royal Artillery. 1534

FIG. 7. KRUPP 28-CM. (11.2-INCH) HOWITZER ON TRANSPORTING WAGON

as well as the hostile transports. This would force the enemy to disembark his troops in small boats well off shore, and would present to us a great opportunity for the use of shrapnel.

Two or more of those batteries should be permanently assigned to each of our coast defenses and every Coast Artillery company should be required to have a land as well as a sea defense target practice with them. In case of war we would then have an available reserve of highly trained troops to man this mobile armament, which could be quickly concentrated at the threatened points of attack. Positions for these batteries should be added to the land defense scheme of our important cities and coast defenses. Portable searchlights and spotting aeroplanes should also be supplied to

complete this equipment. As there are at present good roads in the vicinity of the majority of our coast defenses, this system of transportation would offer an easy solution of the problem of making these elements of our seacoast armament mobile.

Transportation of Heavy Mobile Artillery on Railroad Trucks

Another solution to this problem of mobility would be to mount large guns and mortars on specially constructed railroad trucks or flat-cars. This method has been employed by both sides in the present war, but as yet the reports are very meagre as to the results obtained. We have at present a complete system of railroads along the Atlantic coast of the United States, extending from Maine to Florida, there being only 40 or 50 miles of coast-line that cannot be covered by guns mounted in this way. It would seem that this is too valuable an asset to be overlooked, and that every advantage should be taken of this great opportunity to develop a mobile system of coast defense, which could be used to fill the existing gaps in our present line of permanent seacoast fortifications. We will consider the possibilities of this system under the following heads: first, its strategical value; second, its tactical value.

In discussing the strategical value of this system of coast defense let us assume that two batteries of mortars or heavy howitzers, similar to those previously described, are assigned to each of our coast defenses. Also that they are mounted on specially constructed railroad flat-cars so that they could be fired directly from the railroad track. Upon the declaration of war these mobile trains of heavy artillery should be sent out to patrol those portions of our coast-line lying between our permanent seacoast defenses. To efficiently perform this duty, these trains should be self-supporting, having a complete equipment of wireless apparatus, spotting aeroplanes, machine guns, and searchlights. They should endeavor to keep in touch with the other wireless stations along their section of the coast and be ready to resist any hostile attempt to land. Heavy mobile batteries of this type could be assigned to duty with the mobile army, as previously suggested, and would undoubtedly be of the greatest assistance in checking the hostile landing operations. That portion of our coast-line lying between Portland, Maine and Norfolk, Vir-

ginia, should be immediately protected by some such system of mobile defense.

The value of these same batteries when used in the immediate vicinity of our seacoast defenses and in conjunction with our present armament, would of course be purely tactical. In performing this duty, they could be used to the greatest advantage, as their mobility would confuse the fire of the enemy's ships. The hostile seaplanes would no sooner locate one of these batteries and get the correct range than the battery could take up a new position. To develop this system to its fullest extent a railroad track should be constructed around all our present seacoast defenses and extended well inland for use in land defense. Good positions for batteries, searchlights, etc., should be connected to the main line by railroad spurs. Such a system of heavy mobile railroad armament is especially adapted to the problem of Coast Defense in the United States, due not only to its great mobility and the length of coast-line to be defended, but also to the fact that the batteries from the other coast defenses can be immediately concentrated at the threatened points of attack.

SMALL GUN BATTERIES

We will next consider the subject of small gun batteries. The problem of making these batteries invisible can be solved in many cases by the judicious planting of evergreen trees, and also by covering the emplacements with a piece of canvas painted the color of the surrounding ground. It would be out of the question to attempt to give them sufficient cover against large shell and high angle fire. The best defense for these batteries against the activities of hostile aircraft would therefore be to make them mobile. This would not be difficult and they could be either mounted on a carriage, similar to the present field piece, or mounted on a railroad car, as best suited to the coast defense to which assigned. Each battery should be equipped with a self-contained-base range-finder. The advantages of having these small guns mobile would be that they could quickly take up a new position when discovered by hostile aircraft and could be moved from one coast defense to another.

SEARCHLIGHTS

The question of protecting our searchlights against all methods of attack from hostile aircraft is a serious one. First,

because they will undoubtedly become the target of such attacks and second, because when damaged they would be hard to replace. The present shelters furnished these searchlights are insufficient to protect them against any methods of attack. They are not only vulnerable from the fact that they are extremely visible, but also from a lack of cover and mobility. Trees and vines should be planted around the shelters. The best results, however, from both the standpoint of concealment and cover, would be obtained by sinking the shelters below the surface of the ground and providing them with overhead steel cover and concrete sides. This would protect the searchlights from hostile bombs, shrapnel, and bits of shell. As these lights are only exposed at night, they should be carefully protected during the day. It is also important that they have a limited amount of mobility. This can be obtained by mounting them on wheels or on a railroad flat-car. In this way, if attacked at night by hostile aircraft, they could put out their beams and quickly seek shelter or take up a new position. This is very important as it would not only insure the continuous operation of our searchlights in case of hostilities, but would also permit their being quickly moved from one point to another.

SUBMARINE MINE SYSTEM

The activities of aircraft of all types in modern warfare has introduced a new element into the problem of submarine mining. According to the reports from Europe, aeroplanes have been considerably used for locating submarine mines and for attacking them with counter-mines. They have also been used to direct dragging operations when clearing mined water areas. We must therefore make an attempt to protect our submarine mine system from such methods of attack. This can best be accomplished by making the mines invisible to a hostile air-scout, and experiments should be conducted with this idea in view. It might prove practical to attach a material to the mine case that would give it, when submerged, the appearance of a bunch of seagrass. It has also been suggested to have the upper portion of the mine case finished like a mirror, with the idea that it would reflect the color of the surrounding water and thus become invisible. The best solution, however, would probably be to have a type of submarine mine whose depths of submergence could be controlled from the mining casemates. In this case as soon

as a hostile air-scout was seen to approach the mine-fields, the mines could be sunk to such a depth that he would be unable to locate them.

EFFECT OF DEVELOPMENT OF THE SUBMARINE UPON MEASURES FOR COAST DEFENSE

Let us consider next the effect of the development of the submarine upon measures for coast defense. In studying the operations of the submarines in the present war we find, although at first they threatened to play a most important rôle, that in the last year their activities have been more or less checked. Germany, who has employed these new weapons to a greater degree than the other warring nations, claims to have sunk 568 ships up to the end of last November, which represents a total of 1,079,422 tons. Great Britain, who has borne the brunt of this attack, has lost 5.9 per cent of her total tonnage. Surely with such results as these the submarine is not, as some critics would have us believe, a failure. Great Britain has spared no effort or expense in protecting its fleet and merchant marine, and has finally developed a system of defense which seems to have met with considerable success. As to what these measures are, we are at present more or less ignorant. Nevertheless we do know that there has been a steady stream of transports carrying troops from England and her colonies to France and the Dardanelles, very few of which have become the prey of German and Austrian submarines. Our submarines must therefore expect to encounter the stiffest kind of opposition in attempting to break down the defensive measures that an enemy will surely take to protect his dreadnoughts and transports, when attacking our coasts. It is therefore most important that our submarines practice performing these arduous duties during peace so that, when an enemy does approach our shores, they can strike quickly and strike effectively. According to the Administration Naval Programme we will have in 1921 a fleet of 157 submarines. These vessels can be roughly divided into three general classes, according to their field of activities, as follows:

1. Fleet submarines.
2. Coast defense submarines.
3. Harbor defense submarines.

The fleet submarine is the latest word in submarine construction and is, in reality, a product of the present war, the indications being that this type of vessel will play a most important rôle in future naval warfare. The main characteristics of this class of submarine are as follows: big displacement, great speed, large cruising radius, and armament of rapid fire guns. It is essentially an offensive weapon and is designed to accompany the fleet in its operations on the high seas. This type of submarine is purely a naval weapon and only remotely related to our problem of coast defense.

The next class, or coast defense submarine, although more closely connected to our problem of coast defense than the fleet submarine, is also essentially a naval weapon. This type of submarine is, however, more or less dependent upon the existence of our permanent seacoast defenses in that they protect the navy yards and provide the submarine with a safe base from which to operate. The vessels assigned to this duty would probably be selected from the latest types of coast defense submarines in commission. To efficiently perform their duties, they would be divided into divisions, with the necessary auxiliary ships, and stationed at strategic points along our coast and in our outlying possessions. Their duty would be to guard the coasts of the United States and vigorously attack any hostile expedition approaching our coasts. These submarines cannot, as some ardent admirers would have us believe, sink every hostile ship that threatens our shores. Nevertheless, their presence would undoubtedly have a great moral effect upon an enemy and, when acting in conjunction with our other weapons of coast defense, they should certainly inflict considerable damage upon any hostile expedition.

The distribution and operation of these coast defense submarines in guarding our coast is, of course, exclusively a naval problem. In performing this duty the naval authorities should, however, work in conjunction with the War Department to develop such a system that would enable the United States to meet a hostile landing at any point by an immediate concentration of all its forces, namely coast defense submarines, complete units of the mobile army, and heavy mobile batteries of coast artillery, similar to those previously described. To accomplish this result, it would, of course, first be necessary to develop the coast patrol of scout aeroplanes and fast patrol boats, previously described. This

patrol should have a complete wireless system of its own, that it may be able to discover the approach of the enemy a day or even two days before it could attempt to force a landing. The enemy will be at the greatest disadvantage when he is disembarking his troops and covering his landing operations. This is the time, therefore, that we must be prepared to attack him from both land and sea with all the energy and strength that we can command.

We now come to the problem of the submarine in harbor defense. As previously noted, the theater of operations of both the fleet and coast defense submarine is beyond the sphere of action of our seacoast fortifications and is purely a naval question. With the harbor defense submarine the case is, however, somewhat different, as the harbor to be defended and the theater of operations are common to both the submarine and the coast defenses. It is therefore natural that their interests should be similar and, in order to perform their duties efficiently, they should work in conjunction with one another. This is not intended to indicate that the problems encountered by coast artillery troops are more of a naval than a military character, for, as we have clearly seen in the foregoing pages, they most certainly are not. It only means that in the efficient performance of one or two of their minor duties coast artillery troops need the assistance of submarines. The harbor defense submarine, on the other hand, is absolutely dependent on our coast defenses for support, for without them they would have no safe base from which to operate. The problem that we have to solve is therefore this—"What should be the status of our harbor defense submarine when acting in conjunction with our seacoast defenses?"

The type of submarine assigned to the duty of harbor defense during hostilities will undoubtedly be the older vessels, which, in time of peace, have been held in reserve at the navy yards. If, instead of being so laid up year after year without serving any good purpose, they be assigned to our seacoast defenses, during certain portions of the year, the problem as above stated would be solved to the best interest of both parties. The senior naval officer on these vessels, when so assigned, should be detailed on the staff of the Commanding Officer of the Coast Defenses as his Naval Aide. This would permit a hearty co-operation between both services in solving the problems of harbor defense common to both, and would insure that, upon the outbreak of war, these duties

would be performed in an intelligent and an efficient manner.

In discussing the uses of our submarines we will assume that some such system of co-operation is adopted, which is agreeable to both branches of the service. At the present time the value of the submarine in assisting the coast defenses to perform certain duties is more or less problematical. This is due to the fact that these two services have never had an opportunity to work their problems out together. However, the duties of the harbor defense submarines would, in general, be as follows: first, to attack hostile ships, whether in the vicinity of our coast defenses, or when they are attempting to enter our harbors; second, to reconnoiter the water areas in the vicinity of our coast defenses and to discover the position and movements of the hostile ships. This information would be specially valuable to our coast defenses at night or in foggy weather, when the water approaches to our harbors are invisible from the shore. Timely information of sudden attacks or run-bys under these conditions would be invaluable to the coast defenses in repelling such attacks. Our submarines could also be used to good advantage in protecting our mine-fields against dragging, counter-mining, and other forms of hostile attack. It is apparent that the above duties can only be efficiently performed by the skilful and hearty co-operation of both the submarines and coast defenses.

Let us next briefly consider the uses to which an enemy would put his submarines. First, the main duty of the hostile submarines would be to enter our harbors, attack our warships, shipping, and the water-fronts of our cities. Second, to reconnoiter and discover the position of our batteries, stations, searchlights, mine-fields, etc. They would also be used in attacking our mine-fields by dragging and counter-mining. In devising means of protecting our harbors from the above methods of attack, it would be well for us to make a study of the defensive measures taken by Great Britain, which have been so successful in checking the activities of the German submarines.

We have already considered the methods employed by the British aeroplanes in attacking the German submarines. Another method of defense against submarines that has been extensively used in the present war is that of submarine nets. These nets have been placed by the British in waters frequented by the German submarines. They are similar to woven wire fencing, except that their meshes are much larger. They are

kept submerged, at depths at which submarines operate, by means of wooden blocks and anchors. When a submarine strikes these nets, its fins and propellers become entangled in the wire and it is forced to rise to the surface. As soon as the submarine hits the net an electrical connection flashes the signal to the shore. This enables the shore batteries to quickly open fire on the trapped submarine or to send out other naval vessels to attack it before it can disentangle itself. This form of defense is especially adaptable to many of our harbors, and could not only be successfully used in closing channels, but also in protecting mine-fields.

CONCLUSION

In conclusion, we see that our present system of coast defense should be modified to some extent to keep them abreast of the times. Among the many changes which we would suggest are the following:

First, that an efficient aerial service be developed consisting of a coast patrol, and that our coast defenses be supplied with combat and reconnaissance aeroplanes.

Second, that those elements of our coast defenses which cannot be made mobile should be made invisible to hostile aircraft and provided with adequate overhead and lateral cover.

Last and most important, we find that the best defense we can give our seacoast armament against hostile aircraft, is to make this armament mobile, and thereby extend our sphere of operations to include not only the defense of our harbors, but the defense of our entire coast.

CADET ARTILLERISTS

By 2nd Lieutenant FRED M. GREEN, Coast Artillery Corps

In war with any important power, we may expect that the first branch of our army to become engaged will be the Coast Artillery. In peace we should so arrange that this branch more than any other arm of the service shall be capable of the most rapid preparation for war. For coast artillery there is no possibility of skilful maneuvering to gain time. We cannot fall back, fighting a rear guard action. The initiative is in the hands of the attacking fleet, and the only way to defer a decision is to maintain from the beginning a superiority of fire. In recognition of the long time required to build batteries, our government has been generous in the construction of matériel. There remains the problem of supplying an effective personnel for its service in war.

No one familiar with our traditional military policy will expect any such enormous increase of our regular force as would be required to enable us to man all of our batteries, and preferring half a loaf to no bread, we have *asked* for but one-half the men needed to man the gun and mortar defenses of our own coast.* For the rest, we have hoped to obtain sufficient coast artillery militia, and every inducement has been offered by the War Department for the formation of such units. While a few states have developed efficient forces, the results have been generally discouraging.

When war comes, a large proportion of our batteries will have to be manned by volunteers. We might as well face this unpalatable fact and try and see what use can be made of them. The time available for their training will be very short; it will be measured in days rather than in weeks or months. Can anything be accomplished in so short a period? If not, at least one-half of our batteries had better never been built.

The problem of converting recruits into artillerymen in a few days appears almost impossible of solution. It is

* Annual report of the Secretary of War, 1908.

enormously complicated by the fact that each man in turn must be individually instructed in his own particular duties. This not only multiplies the time required of the instructor, but also divides his attention among many stations often remote from each other. Obviously one man alone cannot instruct an entire battery in the short time which will be available. There will be required for each battery some half dozen assistants, each capable of instructing in his special part of the work, so that instruction may progress simultaneously at the base ends, in the plotting room, and at the emplacements. But these assistants are lacking. The efficiency of our few regular companies must not be undermined by the detaching of their best non-commissioned officers at the outbreak of war. Then, if ever, is the battery commander entitled to the services of all his men. Regular units must be left as nearly intact as possible, or the team work so carefully taught in time of peace has been effort wasted. A smooth running machine should not be broken up for spare parts. The most that can be expected is the detail of subalterns from batteries manned by regular troops. These officers will be required anyway to assume the tactical command of batteries which are normally out of service, and they should accordingly be charged with the training of their volunteer manning parties. But if single-handed, their task can be accomplished but slowly.

Experience with militia indicates that if a skeleton framework of rated men be available, a fairly effective manning party can be made up in a reasonably short time under the direction of a regular officer. If there are a few capable gun commanders, observers and range section men in a company, the time required to train the company will be greatly reduced, for these positions require the greatest amount of instruction, and these men must be proficient before the education of the rest of the company can really begin.

What we most need then is a class of men familiar with artillery matters who will be available for rated positions in volunteer artillery, and who will be capable of acting as assistant instructors for the other recruits. The following project is designed to provide such a class.

Under the Act of Congress of July 2nd, 1862, land was granted to State Colleges were practical instruction should be given in "agriculture and the mechanic arts, including military tactics." Most of these colleges are largely engineering schools.

Cornell University, the Massachusetts Institute of Technology, and the University of California are examples. So far as is known to the writer, all these land-grant colleges give instruction in infantry, and the great majority confine their instruction to that branch.

Unfortunately, this instruction has not proved as successful as might be desired. The average college student fails to enthuse over it. Many are self-conscious and feel ashamed to "play soldier." Others may very reasonably feel that their military training is too brief and vague to qualify them as officers, but realize that they are capable of rendering service more effective than that of carrying a rifle.

The "Summer Camps" of the last few years probably impart more practical information to a student in a few weeks than he would acquire in years of armory drill, because the conditions of service are so much more closely approximated. Drill hall instruction is today of far less proportional importance to mobile troops than it was in 1862, but its possibilities for training coast artillery are just being realized.

Engineering students at these land grant colleges are peculiarly fitted for coast artillery service, by reason of their mechanical experience and mathematical training. In the time now allotted to military instruction, such students could be taught the most essential principles of artillery, qualified as rated men for volunteer troops, and fitted to assist in the instruction of recruits. With a dozen such men as a nucleus, and some muscular eleventh-hour recruits for the manual work, a fairly effective coast artillery company could be developed in ten days. Of course it would not have the steadiness, discipline, and resourcefulness of a regular company, but it should compare favorably with some of the militia, and the tenth day would find it in a condition of effectiveness which could not be attained by an entirely raw outfit in a month. The value of this saving of twenty days in the time of training coast defense troops is too obvious to require comment.

It is suggested that coast artillery instruction be started at some land grant engineering college situated within easy reach of a coast artillery militia armory where position finding equipment and dummy guns are available. The course should be elective as an alternative to infantry instruction, which would suffice to popularize it among the students. Only those possessing natural adaptability and manifesting

a genuine interest should be allowed to pursue the course, and the class for the first year should be restricted in size.

The course should be laid out with the aim of training students first in the general system (basic course) and second in the duties of rated positions and the position finding service. No attempt should be made to develop a tactical unit, except in so far as is required for the proper co-ordination of the technical positions. Gun crews should be made up only as is required for instruction in the duties of gun commanders. As soon as the general system is comprehended, all emphasis should be laid on preparing students to fill the more difficult technical positions which cannot be improvised at short notice, and for which, by reason of their engineering training, they are especially adapted. Any engineering student should master the time-range board in half an hour. For observers and plotters, civil engineering students are especially adapted, and students of mechanical engineering are well prepared to learn the duties of a gun commander. All would possess sufficient mathematical and mechanical aptitude to make their instruction progress with a speed undreamed of in a regular company. It is believed that two hours each week for a college year will afford ample time to enable each student to qualify for every rated position, to gain proficiency in the plotting room and at the time-range board and to learn some of the duties involved in putting a battery into service.

This multiplicity of subjects may appear unwise, as tending to superficiality, but reflection will show its advantages. No man can intelligently fill any important post without a clear insight into the duties of his team-mates. Further, this broader training will render the student more valuable as an instructor, and will fix in his mind those basic principles which are all he can reasonably be expected to remember for any considerable period. The exact procedure of adjusting a certain type of D. P. F. or the minutiæ of the service of a particular gun are not matters to be retained for years in ones recollection. A general knowledge of artillery matériel and methods; all around experience with one or more types of armament; a clear understanding of what is required from each member of a manning party; and, finally, the knowledge of where to look for such other information as may be needed —these are matters which can and will be remembered for some years, and will render a graduate useful at a battery of any sort.

The advantage of this extensive training over intensive specialization is again evident when we consider the certainty of the gradual expansion of our regular force. Increases of the artillery arm are inevitable, and the more widely and favorably this branch is known, the greater the material to choose from in obtaining the officers we shall need. Similarly the Coast Artillery Militia will receive the benefit of an increased popular interest among those of great vocational fitness for its service. These considerations are secondary but tend to confirm this preference for a broad course.

It is my opinion that the entire spirit of this instruction should be technical rather than military. Discipline and ceremony have their place, but instruction in these matters may well be postponed until they are required. A mistaken idea of the military spirit is worse than none. I would suggest that students in this course be not required to wear uniforms, but rather that they should attend their classes in artillery in exactly the same way that they attend their classes in surveying, calculus, or hydraulics.

Such instruction, being entirely devoid of the so-called "tin-soldier" features of the ordinary cadet corps, would attract and interest a great number of students. Realizing their educational fitness for these duties, they would attack artillery problems with enthusiasm. Collectively they would form a reserve of inestimable value to the Coast Artillery service.

Appendix

The attached syllabus is intended as a suggestion for the division of time among the various subjects of instruction. It will be seen that the order in which subjects are presented is radically different from that adopted for the instruction of enlisted men, but it must be remembered that technically trained students will find simple certain subjects which are difficult to most enlisted men, because the problems and methods for their solution will be so similar to engineering methods with which they are already familiar. The student will also have a more analytic attitude than the average soldier, and will not be obliged to mechanically memorize related facts.

The course is based upon an assumed allotment of time of two hours each week. The periods should preferably be consecutive. A term of thirty weeks is assumed, five weeks

of which are left vacant to provide for oral quizzes, visits to nearby forts, or for further instruction on such points as may be considered advisable.

As a type, the dummy armament in the South Armory, Boston, Mass., has been assumed. This consists of one 10-inch disappearing gun, one 12-inch mortar, and one 3-inch rapid fire gun, together with the complete standard equipment for the position-finding service of the first two. For different equipment, modification of the course of instruction might be necessary.

LECTURES	LABORATORY
BASIC COURSE	
1. Kinds of artillery—coast, field, and siege. Guns, mortars, and mines. Their combined use. Tactical chain of command.	Examination of gun and mortar carriages. General principles of same. The laying of guns by Cases II and III.
2. Cases I, II, and III, and their uses. Study of gun and mortar carriages. Telescopic sights and quadrants.	Gun and mortar carriages and their operation. Examination of breech mechanisms.
3. Service of the piece, guns.	Service of the piece, guns.
4. Powder and primers.	Service of the piece, guns.
5. Service of the piece, mortars.	Service of the piece, mortars.
6. Projectiles and fuses.	Service of the piece, mortars.
7. Position finding service. Azimuth instrument. D. P. F. Horizontal, vertical, auxiliary, and emergency bases. Tracking.	Examination and use of instruments. Orientation and adjustment. Tracking.
8. Plotting of a target. Nature of corrections for wind, atmosphere, tide, velocity, and travel. Use of predicted and set-forward points.	Examination of plotting room apparatus.
9. Plotting room of a gun battery.	Gun battery plotting.
10. Plotting room of a mortar battery.	Mortar battery plotting.
GUN COMMANDERS' COURSE	
11. Care of guns. Details of breech and firing mechanism. Subcaliber tubes.	Dismounting of breechblock. Study of details of gun and carriage.

LECTURES	LABORATORY
12. Recoil systems of guns and mortars. Cleaning, care, and adjustment of recoil mechanisms.	Service of the piece, mortars.
13. Orientation, bore sighting, and adjustment of carriages before firing.	Preparation of a piece for firing. The more frequent troubles in firing and at drill, and their correction.
14. Handling of powder, explosives, and primers. Filling and fusing of projectiles.	Service of the piece, mortars.
15. Duties of gun pointers. Indication and identification of targets.	Service of the piece, guns.
16. Intermediate and minor armament.	Examination of minor armament and its service.
17. Time-range board. Use of range differences. Accessories of a battery. Review of duties at the emplacement.	Service of the piece, guns.

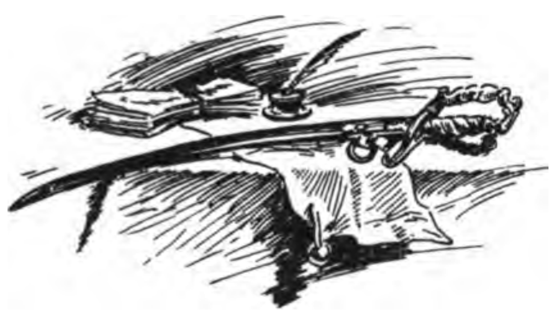
OBSERVERS' COURSE

18. Azimuth instrument, D. P. F. and S. H. B. instruments. Duties of observers and readers.	Adjustment and use of observers' instruments.
19. C. A. telephone. Telephone orders. Review of position finding systems.	Use of C. A. telephone and observers' instruments. Vessel tracking.

PLOTTERS' COURSE

20. Review of plotting and of factors affecting the flight of a projectile.	Gun battery plotting.
21. Arbitrary corrections. Details of plotting, Case II and Case III, for guns.	Gun battery plotting.
22. Mortar battery plotting.	Mortar battery plotting.
23. Adjustment of plotting board from data. Use of auxiliary and emergency bases. Checking of a plotting board.	The actual setting up, adjustment, and checking of a plotting board.
24. Use of trial shots for determining velocity. Danger space correction. Spotting. Review of position finding service.	Mortar battery plotting. Use of auxiliary base.

LECTURES	LABORATORY
25. Tactics of coast defense. Land defense of batteries. Elements of military administration and supply.	Examination: A few practical questions on points which have been covered in the course.



ANGULAR TRAVEL BOARD*

At batteries where the secondary station is located in the battery commander's station in the center of the battery, the travel in azimuth of a target is the same as measured by the secondary instrument and the gun arm. With that in mind this board was first suggested by the plotter, Sergeant Lester Y. Epperson, 10th Company, C. A. C., as a rapid and accurate means of getting travel for use on the deflection board.

Description

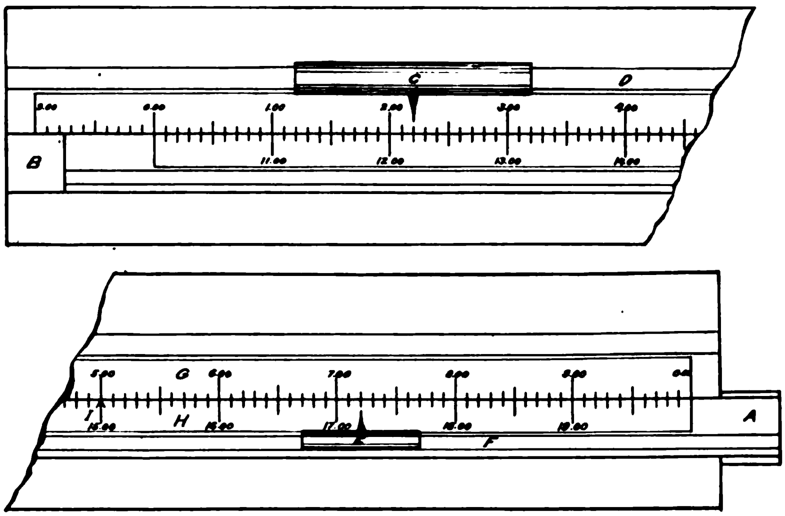
The board is simply an azimuth subtracting device and consists of a rectangular board with two undercut grooves in it—*D* and *B*, (see illustration). Above the groove *B* is a scale *G* graduated in degrees (2″ = 1°) and numbered as shown. On the slide *A*, is a corresponding scale *H* with an index marked as shown. This scale is numbered with reference numbers corresponding to those on the travel scale of the deflection board, the index being 15 or no travel. In the groove *D* slides a marker *C*, and in a small groove *F* on the slide *A* is a smaller marker *E*.

Operation

When the first reading from B″ is announced, the operator, using the last figure and hundredths of the azimuth, sets marker *C* to this reading on *G* and brings the index *I* up to it. As soon as the second reading is received, he brings the marker *E* to this reading on *G* and reads the travel shown by *E* on *H*. He then brings marker *C* up to marker *E*, and moves the slide so as to bring the index *I* up to marker *C*, and waits for another reading. Marker *E* should now show the next or expected azimuth. If it does, he says nothing but resets marker *E*, calls the new travel, and then resets his board for the next reading. This process is continued until the end of the board is reached, then the operator simply jumps back and starts over. In practice, a new travel is not called until

* Furnished for publication from the office of the Chief of Coast Artillery.

it has appeared twice; this prevents errors in azimuth from getting to the deflection board, and the operator soon gets so that he can follow the target and tell about how fast the travel is changing.



ANGULAR TRAVEL BOARD 1771

This board is operated by No. 1 and does away with the tally dials, eliminating the varying travels they give. It also saves the plotter from taking time to set on the plotted points. While it is realized that this system can apply only to batteries having one base-end station in the battery, it gives very uniform and satisfactory deflection board work.

SEARCHLIGHT CARBONS*

By R. B. CHILLAS, Jr.,

Chemical Engineer, Experimental Laboratory, National Carbon Company

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In order that the possibilities and limitations of the searchlight arc may be more clearly understood, a brief outline of the manufacture of carbon products will be given.

The principal raw materials used are lamp black and coke from various sources, together with a number of tars and pitches used as binding materials. The carbon materials are first calcined to eliminate volatile constituents, then ground to the desired fineness, weighed into a mixing machine, to which a definite quantity of the tar or pitch binder is added, and the whole mass then warmed, mixed, and kneaded until a homogeneous and plastic mix has been obtained.

From this point, the various forming processes are carried out. For all illuminating carbons and in general for all carbon rods or tubes, the process is as follows: An hydraulic press has the ram fitted with a piston which can be forced into a cylinder. The warm plastic carbon flour and tar mixture is placed in this cylinder, the ram is brought forward by the hydraulic pressure and the carbon material is extruded through a hardened steel orifice or die in the opposite end of the cylinder. The size of this die regulates the diameter of the finished carbon. Where hollow carbons or tubes are to be made, a tripod is placed back of the die, in the center of which a steel pin of the proper size is supported by the tripod. The mix then flows through the three openings made by the tripod and into the annular space between the die and the pin, emerging as a tube with the outside diameter that of the die, and the inside diameter that of the pin.

The rods are run out onto grooved boards, placed on racks to cool and harden and are then cut to the required lengths. In the case of searchlight carbons, it is customary

* A lecture delivered before the student officers in the Department of Engineering and Mine Defense of the Coast Artillery School, October 15, 1915.

to form the crater and point at this stage of the process, an ordinary drill press fitted with special tools being used.

The carbon is now essentially the same form as desired in the final product. It is, however, more or less brittle and mechanically much weaker than the finished product and is practically a non-conductor of electricity.

The next process is baking, during which the volatile portion of the binder is driven off leaving the coke among the particles of the original carbon flour, and thus producing the homogeneous and conducting product with which you are familiar. In the baking process, the carbons go through the plastic stage similar to that in which they are formed; consequently, it is necessary to pack the green (or unbaked) carbons very carefully in the furnaces in order that distortion shall not take place. Each carbon is placed individually by hand, in coarse coke, so that no two carbons shall touch each other. During the baking process, which usually requires from ten days to four weeks, the carbons shrink very perceptibly, for which due allowance must be made in the forming operation above mentioned.

After the furnaces have cooled sufficiently, the carbons are unpacked, inspected for straightness and other deformations, gauged for diameter, and, if necessary, pointed and butted to the proper lengths. With hollow carbons the core material, with its arc steadying salts or flame materials, is squirted into the core hole and then dried. After cleaning and inspecting, the carbons are ready for shipment. This gives briefly, an outline of the manufacturing process.

It will be realized from the above, that there are certain physical limitations which may be considered. For example, the rate of consumption in a lamp, the electrical resistance, or the hardness may be controlled somewhat by the carbon manufacturer; but after all, we are dealing with one of the chemical elements, and so long as we restrict ourselves to carbon, the range of control of the various properties is decidedly limited, and attempts to exceed these limitations not only give uncertain results, but also become increasingly expensive. It is, therefore, advisable to adopt only such restrictions as are necessary and compatible with the demands of satisfactory service.

The thing that can be controlled by the manufacturer is the size of the carbon. In taking up the discussion of the searchlight, it will be seen to how great an extent proper sizes can be made to serve our purposes.

The Considerations Governing the Choice of Proper Carbons

The principal considerations governing the choice of the proper carbons for searchlight requirement are, first, that the desired service characteristics shall be obtained in the maximum degree, and second, that only such manufacturing problems shall be presented as offer a reasonable possibility of successful solution.

The desired characteristics are that the positive crater of the arc shall be maintained at the focal point of the parabolic mirror, and that the lamp mechanism and the carbons shall be so co-ordinated as to bring about this condition with the minimum of attention on the part of the operator. The essential requirement for this is that the lamp mechanism shall advance the carbons at as nearly as possible the same rate as that at which they are consumed.

The types of lamp mechanisms available are those that have:

1. A fixed feeding ratio.
2. A variable feed ratio, under control of the operator.
3. A semi-automatic feeding mechanism. (See Beck lamp.)

The first type largely predominates, and since this presents the most severe carbon conditions, the discussion will be confined to this type only. Carbons for such a type of lamp will meet the conditions for the other two. It may be noted that manual focussing in the first type of lamp is obtained by shifting the entire lamp mechanism backward or forward on a carriage in the drum.

The basis upon which the present work was carried out is that the function of the positive carbon is to produce a light of the maximum efficiency, steadiness, and concentration, while the negative carbon, which is the more important from an electrical standpoint, must maintain a steady arc, cause the least possible sacrifice in the efficiency and permit the required degree of control of the linear burning ratio of positive to negative. The principal questions, therefore, are "what are the characteristics as to size and texture of the positive and of the negative carbon which will give this combination in the best form?"

Several authors have given the requirements of searchlight carbons (see list of references). Lieut. G. S. McDowell, U. S. N., in his paper on "Searchlights," in the *Proceedings of the American Institute of Electrical Engineers*, February, 1915, page 195, gives the following concise summary.

The desired searchlight arc should excell in the following particulars:

1. Small positive crater, with high current densities, and thus high crater temperature throughout the crater area, which gives high intrinsic brilliancy.
2. Small negative carbons.
3. Long arc length.
4. Uniform mixture of carbon. So as to help evenness of burning.

The present discussion mainly concerns the first three of these. The importance of the last is fully realized by the manufacturer and need not be taken up at present.

Experimental Observations on Arc Behavior and Carbon Operation

In experimental tests on the present standard sizes it was found that when the arc is on the negative shell, instead of on the core, the arc stream issues from a very small bright spot apparently as a high velocity blast, in a direction normal to the carbon surface. If this surface is directly facing the positive, the stream is straight and usually steady; if not, the arc must bend toward the positive, and unsteadiness, hissing, and rapid wanderings of the arc occur, often resulting in an outrage (arc break).

For a 200 ampere 70 volt arc, the diameter of the negative spot is estimated at .07 inch to .10 inch (1.8 to 2.5 mm.) corresponding to a current density of 25,000 to 50,000 amperes per square inch (3900 to 7800 amp. per sq. cm.). The diameter and the current density of the positive bright spot or arc crater are respectively .8 inch (20 mm.) and 400 amp. per square inch (62 amp. per sq. cm.). The term arc crater will be used to indicate the sharply defined bright spot on the positive carbon. The term carbon crater designates the cup shaped depression which forms where the arc crater is located. This difference is seen only when one looks into the positive crater through a sufficient thickness of densely colored glasses, such as two thicknesses of signal green and one of signal red glass, each about one sixteenth inch (1.5 mm.) thick. Unless a dense glass is used, the whole carbon crater appears to be of dazzling brightness.

Characteristics of the Negative Carbon

In operating large negatives, such as the G. E. 36-inch and the foreign 100 ampere 21 mm. or similar larger ones (current densities below 200 amp. per square inch or 30 amp. per sq. cm.), the prevailing shape of the tip of the negative is blunt and rounded, or even slightly cupped with cored negatives. With such a shape periods of marked unsteadiness and troublesome burning are almost certain to occur. At such times the arc leaves the core, hisses and chases about over the end of the negative, usually stopping for a while on the edge of the shallow crater. This tends to burn away this edge and finally rounds the end of the negative. In the mean time, the positive crater has been so badly burned out of shape that it is difficult to control the arc for a while and several outrages are apt to occur. The appearance of the positive crater reminds one of an octopus, with many rapidly moving tentacles. The efficiency at such times is very low, 30 per cent of normal. The negative will finally become sufficiently rounded, and the arc becomes steady for 20-30 minutes, to be followed by another spasm of 3-5 minutes of poor burning; this cycle repeats through the life of a trim. The operator can do very little to overcome such trouble; it appears to be due mainly to a faulty choice of sizes.

It was noticed that very good, steady arcs occurred provided a favorably shaped point was obtained, on which the tendency to wander was diminished; that the core in the negative is non-essential; that such a carbon would probably be of small diameter, and this, if true, would give an added advantage in that the shadow region, due to the negative, would be decreased. Some heavily copper coated solid carbons with diameters ½, ⅝, and ¾ inch (13, 16, and 19 mm.) were tried on the 60-inch lamp at 200 amperes. These indicated the value of the small negative.

With a properly chosen grade of carbon, very interesting results were obtained. The negative bright spot scarcely wanders from the tip of the carbon, when the carbon diameter is properly chosen. In fact a small graphitized "wart" about 0.10 inch in diameter forms on the end of the carbon, and the arc persistently stays on this tip.

Positive Carbons—Choice of Sizes

On the G. E. 60-inch lamp, using 2-inch diameter posi-

tive and 1⅜-inch negative, at 175 or 200 amperes, the arc on the positive wanders sufficiently to keep a fairly well formed carbon crater, though the actual arc crater or hot spot does not nearly cover the end of the carbon. This necessarily leads to unsteadiness and poor efficiency in the searchlight beam, as the bright spot can not be accurately held at the focus, and the average crater temperature, or instrinsic brightness, is comparatively low.

With a negative as above described, the arc stream is directed steadily at a spot on the positive, where a bright sharply defined arc crater appears, and a cup shaped arc crater begins to form. Continuing the operation, a very deep crater may form (if the positive is large) until finally the tip of the negative is within the crater, and the arc burns against the sides, tending to give a somewhat spherical hole within the positive.

It was then seen that a material improvement could be made by decreasing the size of the positive. In a series of tests to determine the proper size, an interesting series of observations were obtained on crater formations under different conditions.

High grade positive carbons with a small 418-C core and ⅝-inch copper coated coke solid negative were used, at a current of 200 amperes and 68-70 volts.

Carbon Diameter inches	*Crater Characteristics*	*Steadiness*
1.0	Rounded end of carbon, arc crater overlapped end, hissed badly	Very poor
1.125-1.25	Nearly flat crater, sharp edges	Fair
1.375	Good cup-shaped crater, sharp edges, arc crater nearly covered the carbon crater. Best general condition	Excellent
1.50-1.625	Deeper crater, outer edges slightly rounded, good general condition	Good
1.75-2.00	Crater very deep, with nearly parallel sides. May be wider at bottom than at mouth. Negative tip within crater, very noisy, outer edges more rounded	Erratic, good or very poor

As the diameter increases, spindling and the rate of consumption decreases. The smallest plain carbon that can be used under the present scheme of operation, that is, without the use of devices to prevent spindling, as in the Beck and

other schemes, is the one in which the arc crater very nearly covers the end of the positive, as in the $1\frac{3}{8}$-inch carbon in the table on page 196.

Another series of tests with $1\frac{3}{8}$-inch positives and $\frac{5}{8}$-inch copper covered negatives, and varying the current and voltage slightly gave the following:

Current		*Arc Voltage*		*Crater Formation*
Normal	– 200 Amp.	Normal	– 68 volts	Normal
Normal	– 200 "	Lowered	– 66 "	Tends to deepen
Normal	– 200 "	Raised	– 70 "	Tends to flatten
Raised	– 210 "	Normal	– 68 "	Tends to flatten
Lowered	– 190 "	Normal	– 68 "	Tends to deepen
Raised	– 210 "	Raised	– 70 "	Flat, unsteady
Lowered	– 190 "	Lowered	– 66 "	Rapidly deepens

The application of these results will be more fully considered under "operating notes."

While the crater formation is controlled principally by the carbon size, the influence of the texture of the carbon must be considered at the same time. The first question that enters with changes in texture is that of spindling. Since this is a problem which is far from being well understood, the present notes may be of only passing interest. As spindling increases, the available carbon area at the tip may become insufficient for the crater area and unsteadiness results, as in the small carbons above. A carbon of sufficient size must be selected such that when it has spindled to its natural shape the end will be large enough for the crater.

The function of the positive, as has been seen, is to maintain the crater at the maximum brightness and steadiness. The conditions which appear best to meet these requirements are that the arc crater shall almost wholly occupy or cover the end of the positive carbon, so as to form a symmetrical cup-shaped carbon crater. Under these conditions the average temperature throughout the carbon crater is virtually that of the arc crater. This gives a sharply defined beam of high efficiency, since there is no low temperature radiating surface facing the mirror at the focus. Furthermore, the crater being definitely located on the end of the carbon, it cannot wander laterally out of focus, and hence there results a steadier beam.

A further improvement has also been made by cutting down the size of the core hole in the positive. The core appears to be considerably darker than the surrounding bright parts of the crater; it is therefore advantageous to have it

no longer than necessary to give the required arc steadiness. With the new steady negatives, the positive core areas have been reduced to 25-30 per cent of the former sizes. The sizes of positive carbons which most nearly fulfill the requirements for this type of service are given in the appendix.

Negative Carbons—Choice of Sizes

Having found the most favorable character of negatives, and selected the sizes of positives for different currents, the determination of the proper size of negatives was then undertaken. The requirements, as mentioned above, are that the arc shall be steady, that the negative shall cause the least possible sacrifice in efficiency and shall give a practicable burning ratio.

The negative carbon is the more important from electrical considerations. The influence of the texture of this carbon on steadiness has been discussed above. The maximum operating arc voltage with a given line voltage is measured by the permissible number of outrages, or arc breaks, within a given time. For a given degree of steadiness thus measured, a good negative permits operation at a high arc voltage, thus giving increased power consumption in the arc with greater over-all efficiency, a larger positive arc crater and a longer arc with a consequently smaller solid angle included in the negative shadow region, especially if this carbon is well pointed.

In tests to determine the proper size, it was found possible to choose a plain negative, which will have the capacity to carry continuously such a current as will give a positive crater covering the tip. A carbon of this size, however, will tend to burn blunt, and hence is unsteady. This statement applies more particularly in the case of currents above 75 amperes for reasons which will be discussed below. Smaller carbons tend to spindle excessively, but the steadiness usually improves as the tip becomes pointed. For 100-110 amperes a 1-inch diameter carbon is about at full load, and spindles approximately 3 inches. Increased current carrying capacity is therefore required, and may be secured as follows:

1. By increased diameter. This is in the direction away from steadiness, as shown above.
2. By changes in mix. This is also expensive and of very limited range, as shown by years of almost vain efforts to get satisfactory results with the present sizes.

3. By copper coating. This is by far the simplest and offers a much wider range of control and better burning conditions than any of the above.

With positives chosen as above described, it has been found that by successively decreasing the size of the negative and at the same time increasing the amount of copper coat, the necessary current carrying capacity can be maintained and a tip shape increasingly favorable to steadiness is obtained. The practical limit to which this may be carried is the point beyond which a further increase in the amount of copper does not yield an adequate return in burning quality and control of the burning ratio.

It has been found that beyond a certain point further increases in the amount of copper give a relatively small decrease in resistance. In operation, such a small heavily coated carbon, worked at a high current density, melts the copper off at the tip, consumes very rapidly, and gives no better steadiness than a slightly larger carbon with less copper. The best negative therefore from the standpoint of efficiency and steadiness is such a one as will require somewhat less than .003 inch copper to give satisfactory continuous operation. Next in importance is the determination of the natural burning ratio and the corresponding choice of the proper lamp feeding ratio.

The above tests, made for the selection of the proper negative, have shown that quite an appreciable change may be made in the rate of consumption, either by changing the amount of copper or by slight changes in diameter from that which gives the test steadiness. This then presents the opportunity for a certain degree of control over the burning ratio, so that the most suitable lamp feeding ratio may be adopted.

Natural Burning Ratio

It was found that with positives and negatives selected as above described, the natural burning ratio, while increasing as the size of carbons increases, is or can be made to be essentially 1 to 1 for a large number of the usual sizes, with but little or no sacrifice in efficiency. As this corresponds to the simplest lamp construction, the trim sizes were selected to correspond with this feeding ratio except as noted. This feeding ratio appears to be quite generally standard among

the principal lamp makers, except that one large American manufacturer, who has supplied a number of lamps to both the Army and Navy, has used a 1.65 to 1 ratio for a number of years.

The trims given in the following table (see appendix) were chosen of such sizes that the normal grades of carbon mixes will give their best obtainable service.

Life

The available burning hours of the new trims is considerably less than that obtainable in the previous sizes. This is the only important point in which the advantage lies in favor of the old sizes.

Average figures from tests in the present G. E. mechanism show the following results:

Size in inches

60-inch	$1\frac{3}{8}$ x 15 Pos.	$\frac{5}{8}$ x 12 Neg.	3.00-3.75 Hrs.
36-inch	$1\frac{3}{8}$ x 10 "	$\frac{1}{2}$ x 9 "	2.75-3.50 "
24-inch	$\frac{3}{4}$ x 10 "	$\frac{3}{8}$ x 9 "	3.00-3.50 "
Small lamps, 18-, 13-, and 9-inch			3.00-3.50 "

The advantages in operation greatly outweigh the somewhat short life.

Effect of Current on Burning Ratio

An interesting and very important feature which has been observed in the testing of these and some of the foreign carbons, is that the ratio of volumes consumed increases as the size of carbons and current increases; that is, a larger volume of positive carbon is consumed for a given volume of negative carbon in the larger sizes than in the smaller ones. Since the ratio of volumes consumed is equal to the product of the ratio of the area of positive to negative by the linear burning ratio of positive to negative, and since for a given set of conditions this has been found to be nearly constant, it follows that for a given volume ratio, either the area ratio or the burning ratio must be changed as the size increases.

It has been found that the cross section of a copper coated negative which will burn with a well pointed tip and which lies in the region of the best control of the copper coat, is proportional to the current plus a constant.

With positives selected to have a crater covering the tip,

it is found that the current density increases as size increases. Since the radiating surface per unit volume decreases, and the wattage per unit volume when the carbon has burned to shape rapidly increases with increase in diameter, the operating temperature of the tip tends to rise and therefore the rate of consumption of the positive increases at a rate more than proportional to the current.

If it is desired to maintain a given lamp feeding ratio, the diameter of the positive must increase faster than the current in order to keep the crater at the focus.

The 1-1 lamp feeding ratio chosen most nearly fulfils the requirements of good burning, for normal grades of carbon in the range of currents between 50 to 125 amperes. The sizes of positive to give 1-1 burning ratio at 150 and 200 amperes are too large for the best burning conditions, but since the 150 ampere size is not much used in American practice, though quite common abroad, the 1-1 ratio has been adhered to for this trim.

For the 200 ampere size 68-70 arc volts, the best positive is about 35 mm. ($1\frac{3}{8}$ inches), and with a 16-mm. ($\frac{5}{8}$-inch) negative the burning ratio is about 1.35 to 1. For 1-1 burning, the positive must be 40-41 mm. ($1\frac{5}{8}$ inches) in diameter. The smaller size is preferred.

For currents less than 50 amperes and 1-1 ratio lamp, the positive must be smaller than that required by the crater conditions. Decreasing the negative leads to short life, since the available burning length is ordinarily rather small. Hence slightly faster burning positive has been chosen for these smaller sizes.

In connection with the above discussion, it has been found that a 10 per cent variation either side of the rated current may be made without appreciably affecting the burning ratio.

Notes on Operating Characteristics

The "Notes on Searchlight Operation" given below is a copy of our note of April 8, 1915, prepared at the time some 60-inch samples were sent to the U. S. Army, Fort Monroe, Va. This note has also been sent to the U. S. Navy Yard, Brooklyn, N. Y., and the General Electric Company, Schenectady, N. Y. While some of the items have been discussed, it is considered worth while to present the full text herewith.

Notes on Searchlight Operation with Particular Reference to 60-inch Size

Observations on the operating characteristics of the newly developed searchlight carbons have shown certain details which may prove of advantage in obtaining reliable service. The new trims make use of a small copper coated negative together with a positive considerably smaller than the present standard size.

The best condition for combined efficiency and steadiness of the arc appears to be found when the positive crater is approximately an hemispherical recess that covers the end of the positive carbon, in conjunction with a tapering point on the negative carbon.

With a positive carbon of the proper diameter operating at its normal current the above condition will be obtained when the arc voltage is normal. With low arc voltage, the crater area decreases, less power is consumed in the arc and the crater tends to become deep; the arc is less steady, hisses, and the negative cuts off more light on account of the shorter arc.

With high arc voltage the crater area increases, more power is consumed, and the crater tends to flatten, so that it becomes difficult to operate; in addition, the limit of electrical stability is approached and the tendency to outrages is increased. By carefully regulating the arc voltage it is usually possible to keep the crater properly shaped. In case the voltage has been raised as high as practicable, and the crater is still deep, the current should be increased slightly.

The negative carbon is of the most importance in maintaining steadiness, the best condition being with a pointed negative. The length of the negative point depends very largely upon the behavior of the copper coating. It has been found that with care, an experienced operator can burn off the copper a short distance from the tip by moving the positive carbon slightly so as to cause the arc flame reflected from the positive to play under the negative carbon for a moment.

The carbons for the 60-inch lamp selected with the above conditions in view are: Positive, 1⅜-inch (35-mm.) diameter; negative, ⅝-inch (16-mm.) diameter; for normal operation at 200 amperes, 70-75 arc volts. The negative tip should be about ⅞-1¼ inches long.

In giving these notes it is realized that variations are certain to occur in lamp mechanism, current supply and methods of operation as well as in carbons, and that those variations all have a rather cumulative effect on the operation of the carbons. It is assumed that the importance of the 60-inch lamp is such that operators are continually in attendance so that the irregularities in operation can usually be anticipated and the correction applied before trouble commences.

The above notes are therefore given with the belief that they will be of assistance in securing good operation under the variations which, although kept as small as practicable, are nevertheless bound to occur.

In the 36-inch lamp using 110 amperes with 1⅛-inch (29-mm.) and ½-inch (13-mm.) carbons the power consumption is smaller and the necessity for the same degree of care is not so great as in the 60-inch lamp. However, much the same principles can be usefully applied to this lamp.

In addition to the above, interesting observations on searchlight operations are given in *Electrical Engineering*, January 28, 1915, and in *Illuminating Engineer*, February, 1915, both published in London.

An observation by Mrs. Ayrton bears particularly on our new trims. She suggests that both positive and negative carbons should be adjustable. In this way, with the positive once adjusted to be in focus, it may be allowed to remain in position while the negative is moved as necessary to control the arc. At present, only the positive is adjustable in the G. E. lamps.

Intermittent Operation—Effect on Burning Ratio

All of the preceeding discussion has been based on steady operation. The lamp once started shall be burned continually during the life of a trim. It is probable, however, that much of the ordinary use of searchlights is of an intermittent nature: that is, on for periods of 30 minutes or less, and off for 10 minutes or more.

Upon starting a fresh trim of the new sizes, the behavior is somewhat as follows: The amount of energy available at the positive appears sufficient to warm up the end of the positive carbon (assuming that the end is pointed and cratered to approximately its natural burning shape) within 3 to 5 minutes, so that equilibrium conditions are rapidly attained. On the negative tip, the energy available from the negative itself and radiated from the positive appears to be insufficient to produce steady conditions within a period of 10-15 minutes, (with large negatives, 30 minutes or more may be required).

During this time, the point of the negative is usually burned off and the tip becomes rounded; following this, it then begins to shape itself to its natural form. The linear rate of consumption is much slower during this starting period than later. The burning ratio therefore is increased, so that the crater movement tends to be toward the positive for a time. Later, when the results are relatively small, the cooling effect of the holders becomes more prominent, and introduces another change in buring ratio, usually in the direction of slower negative consumption. It is therefore evident that a trim which, burned continually, shows the correct burning ratio when the stubs are measured, does not necessarily maintain the crater in focus during the entire run.

If the operation of the lamp is intermittent, the above described starting phenomena are repeated at each new start. The net result is that the rate of consumption of the negative is decreased, giving an increase ratio and a tendency towards a positive crater movement.

Our new trims, however, maintain their advantage under these conditions, because with the small negatives steady

conditions are reached in a much shorted time than with the larger ones.

It should be noted here that the effect of intermittent operation is different with different classes of carbons. Owing to the wide variety of possible conditions, but little testing was done along this line.

Developments Using the Flame Arc

A few notes concerning the use of the flame arc for searchlight purposes may be of interest. Several articles have appeared in the technical press concerning the Beck lamp and its alcohol-vapor cooling devices.

At the present time there are several concerns in this country who are actively interested in the development of the lamp, in conjunction with the work on the carbons now being carried out in our laboratories.

An experimental lamp from one concern is now at our factory for tests on the carbons as they are being made. The essential features of the scheme as they appear from observation of these tests are as follows:

It has been found that the positive arc crater on an impregnated flame carbon is of decidedly smaller area than the crater on a pure carbon. Advantage has been taken of this fact to secure a much more concentrated source of light with a given current than is possible with the plain carbon; in addition, by the proper choice of the flame material, a further increase in the quantity of light is secured.

The carbons for this work are of special design, using a pure carbon shell with an impregnated flame carbon core. These carbons are operated at a very high current density, so high, in fact, that the carbon would not carry the normal current without becoming red hot and oxidizing rapidly. For this reason special cooling devices are required; only a very short length of carbon actually carries the current and this is wholly within the cooling chamber of the carbon holder. A small length of carbon must project out of the holder at the arc, but the linear rate of consumption is sufficiently rapid to prohibit excessive surface oxidation; that is, the carbon extending out of the holder is consumed before it has time to spindle materially.

It should be borne in mind that the current carrying capacity of a (metallic) conductor is limited mainly by the operating temperature, so that the current can be raised pro-

vided that adequate cooling methods are used. Thus it is possible to carry currents which would be otherwise destructive to the carbon by proper cooling and protection from oxidation.

The negative carbon is also of small diameter and is properly cooled. For example, the carbons now under test in a 150-ampere lamp are a 16-mm. (⅝-inch) flame cored positive and a 11-mm. (7/16-inch) cored negative. The actual positive crater is about 14 mm. in diameter. In operation, the negative carbon is inclined at an angle of about 20° below the axis and in such a position that the central tongue in the negative arc flame strikes about on the upper edge of the positive crater. The positive carbon is continuously rotated and fed forward and forms a symmetrical crater about 10 mm. deep, filled with the highly luminescent gas of the flame arc. This gives an extremely concentrated light source of high candlepower, which is practically ideal for the searchlight requirements.

While the writer is not familiar with the degree of accuracy of focus in the parabolic mirror, it appears to be probable that the mirrors must be of very high quality in order to utilize this light to its best advantage.

It is still too early in the development to say what limitations exist. At present, it appears to be essentially a high current proposition; that is, for currents of 100 amperes and over. For smaller lamps the operation does not appear to be as good. Incidentally, the carbon problem in the smaller lamps may prove to be the limiting feature, more from the standpoint of the user than from the carbon maker. The smaller lamps are generally of the portable type, so that the extreme care necessary in the handling of the long, thin carbons such as would be used in this type of lamp may limit their use. For currents over 100 amperes, we will not attempt to discuss the limit. We do not know where it is, as the apparatus for testing is not at present available.

A comparison of the Beck and the Sperry lamps, shows the following essential differences, this information being derived from the several published accounts of the Beck lamp and from conversations with the representative of the Sperry Gyroscope Co., whose lamp has been observed under test. Differences in the mechanical arrangement of the feeding and rotating devices need not be discussed. The important differences are in operating principles. The Beck lamp

makes use of a spray of alcohol or other similar hydrocarbon against the hot tips of the carbons. The alcohol ignites, but the temperature of its flame is said to be sufficiently below the operating temperature of the tips to act virtually as a cooling agent. In addition, the products of combustion act as a protective sheath, to prevent undue oxidation. Since alcohol is not permitted aboard warships, it will probably be necessary to use some other material. In the Sperry lamp, cooling is accomplished and spindling prevented by means of an air cooled copper radiator which surrounds the positive nearly up to the tip. Immediately in front of this radiator is a short fused silica tube out of which about ½ inch to ¾ inch of carbon is allowed to project. Air is supplied by a small motor driven blower to this radiator and also to the negative holder.

Candle Power Measurements

With the development of the new trims the question arose as to the extent to which the candlepower had been increased.

Two methods have been used for this measurement, the first being the "point by point" method, which is both tedious and unsatisfactory; the second is a method developed in this laboratory using the integrating sphere, which it is believed will prove generally useful for this type of work.

INTEGRATING SPHERE METHOD

The following method has shown itself to be a very decided improvement in the measurement of the light produced by the searchlight arc that falls within the effective region. The following description of the scheme is a copy of our note of June 3, 1915, as sent to Lieut. C. S. McDowell, U. S. Navy, Brooklyn Navy Yard, N. Y. This is the method referred to in the writer's discussion of Lieut. McDowell's paper on "Searchlights," *Proceedings of the American Institute of Electrical Engineers*, February, 1915.

Method and Apparatus Used in Measuring the Effective Candlepower of Searchlight Carbons

APPARATUS

Eighty-one inch (about 2 meters) Ulbricht integrating sphere, which is divided vertically into two hemispheres, Sharp Miller portable photometer (or similar instrument). Mean spherical candlepower standard incandescent lamp. One large incandescent lamp, preferably a high power gas filled

tungsten, equipped with an opaque reflector so as to throw all of its light into one hemisphere. This lamp is to be used as an auxiliary standard. Searchlight lamp mechanism and rheostat, necessary meters.

METHOD

The theory of the Ulbricht sphere is well discussed by Messrs. N. K. Chaney and M. L. Clark of this laboratory, in the *Transactions of the Illuminating Engineering Society*, Vol. 10, No. 1, 1915, page 1. The precautions therein given should be observed.

It has been shown that any bright patch on the inside of a sphere having a diffusely reflecting surface illuminates every other patch equally. This is true also for any portion of the inner spherical surface, for instance, a hemisphere.

The scheme employed in the measurement of the effective mean candlepower of the searchlight arc is to compare the illumination produced on a given spherical surface by a source of known total flux, with that produced by the effective portion of the light from the arc under test.

Proceed as Follows.—

In the sphere determine the mean spherical candlepower of the high powered incandescent lamp equipped with its above mentioned reflector. In making this measurement, place the screened side of the lamp facing the test plate, and remove the circular screen from the sphere. (The reflector acts as a screen, see Chaney and Clark paper, pages 13 to 16.) This gives the total flux for this lamp, which will be hereafter used and designated as the working standard. (This standardization should be checked after every 10 hours of burning.) Now open the sphere and remove the rear half (or cover it with black cloth). Also arrange black screens so that no stray light falls upon the open hemisphere, when it is placed in the position in which it is to be used. Remove both of the regular screens, and substitute a small white blotting paper screen so as to cut off from the test plate all of the direct light but none of the diffusely reflected light from any part of the sphere. A screen 4 inches in diameter placed 6 inches from the test plate will do this.

Set up the searchlight lamp with the positive crater facing the opening, and at such a distance from the circular rim that the solid angle subtended by the rim is exactly the same as that subtended by the mirror when the lamp is in use under service conditions; this effective angle differs for different lamp makers, but the usual angle is 60 degrees from the axis (120 degree solid angle). With an 81-inch sphere diameter, and using the 60 degree angle, the positive crater should be set on the horizontal axis of the sphere at a distance of 40.5 inches ÷ tan 60 degrees = 23.4 inches from the plane of the rim; or, more conveniently, at a distance 40.5 inches ÷ sin 60 degrees = 46.8 inches from the rim. A measuring stick cut to this length may be used conveniently to check the setting. In order that the arc position may be verified while the lamp is in operation, two sticks should be set up at some distance either side of the arc, at about 18 inches and 23.4-inches from the plane of the rim. Discrepancies between the burning ratio of the carbons and the feeding ratio of the lamp may be eliminated by keeping the crater in line between these sticks.

Having the arc lamp and all of the auxiliary apparatus in place, hang the working standard lamp at about the center of the sphere in such a position that all of its light falls within the hemisphere. Check this by observa-

tions from various positions around the rim, or by noting the absence of any sharply defined shadows cast by an exploring stick or pencil held just inside of the edge of the rim.

Take a series of readings of the illumination of the test plate with the working standard burning. Then remove this lamp and start the searchlight, allowing it to burn long enough to warm up and form its craters. Check the crater position (in line with the sticks) before taking any readings, and before each series of readings. After burning 30 minutes, take two series of 25 readings each, 15 minutes to a series, with 5 minutes interval between each series. At least 5 pairs of carbons from a lot should be tested, in order to establish reasonable certainty in the final results.

Calculate the effective mean spherical candlepower of the arc as follows:

Given the mean spherical candlepower of the working standard in its reflector, the photometric readings with this lamp burning, the photometric readings with the searchlight lamp burning and the transmission coefficients of any absorbing screens used, the effective mean spherical candlepower of the searchlight is given by the equation:

$$\text{M. S. C. P. of searchlight} = \text{M. S. C. P. of working standard} \times \frac{\text{screen coefficient for standard}}{\text{average reading for standard}} \times \frac{\text{average reading for searchlight}}{\text{screen coefficient for searchlight}}$$

(Both screens were on the sphere side in the photometer.)

The figure of the searchlight M. S. C. P. is in terms of the equivalent M. S. C. P. of the light falling within the effective angle, in this case 120 degrees. (The value in terms of lumens is given by 4π M. S. C. P.) To obtain the mean effective intensity of the light that falls upon the mirror, multiply the M. S. C. P. of the arc by the ratio of the total sphere area to that subtended by the effective angle. The reason for this is as follows:

The working standard is so screened as to illuminate only half of the sphere, but it is standardized in terms of mean spherical candlepower. When it is used as a standard, its total flux of light falls upon the hemisphere and the photometer reading is proportional to this M. S. C. P. Since the searchlight crater is so placed in relation to the mirror that only the light within the effective solid angle is useful, and since the spherical surface subtended by this angle is given by $1 - \frac{\cos \theta/2}{2}$ ½ versin $\theta/2$, the effective mean spherical candlepower must be multiplied by $\frac{2}{1-\cos \theta/2}$ to obtain the mean effective intensity in the direction of the mirror.

(For 0° to 120°, $\frac{2}{1-\cos \theta/2} = 4$; that is, the mean intensity on the mirror is 4 times the M. S. C. P. value.)

A complete set of sample calculations are given herewith. (The 200 ampere lamp was used in this test.)

Standardization of *gas filled* lamp with reflector, (sphere closed).—

Candlepower of standard lamp	335 M. S. C. P.
Absorbing screens	Transmission coefficients
Light green	.220
Dark green	.040

Photometer reading on standard ...27.2 (with light screen on standard side)
Photometer reading on test lamp...53.5 (with light screen on test lamp side)

$$\text{M. S. C. P. of working standard} = 335 \times \frac{.220}{27.2} \times \frac{53.5}{.220} = 660 \text{ M.S.C.P.}$$

M.S.C.P. test of searchlight, (using hemisphere).—

M. S. C. P. of working standard........660 (as found above)
Photometer reading of working standard..25.1 (light screen on working st'n'd)
Photometer reading on searchlight...... 88.2 (dark screen on arc side)

$$\text{Effective M. S. C. P. of searchlight} = 660 \times \frac{.220}{25.1} \times \frac{88.2}{.040} = 12{,}750$$

M. C. S. P., or 160,100 lumens.

The mean effective intensity in the direction of the mirror is given by $12{,}750 \times \frac{2}{1 - \cos 60 \text{ deg.}} = 51{,}000$ candlepower.

The factor $660 \times \frac{.220}{25.1} \times \frac{1}{.040} = 144.7$ may be used throughout each day's work.

This should be obtained at the beginning of each days' work by each man who will read the photometer that day. It takes into account the condition of the observer's eyes, and also the condition of the surface of the sphere.

The photograph and sketch* show the general arrangement of the apparatus. The reflector used on the standard lamp was a cone asbestos paper, mounted on a wire hoop, and painted white inside. The circular frame supporting the regular screen may be left in place without appreciable error (or rotated 90 deg.); the small screen may be supported by a light horizontal stick fastened to the vertical rod which normally supports the screen.

The use of this method permits a much greater accuracy to be obtained and at the same time cuts down the time required for a test. It is particularly useful in determining the time required for a new trim to come up to full candle power, since anyone reading gives the integrated value of the light at the moment the reading is taken, and does not depend on the idiosyncracies of the wandering of the arc.

It should be noted that the mean effective candlepower or total light flux falling on the mirror, by whatever method it is measured, does not fully represent the value of the carbon for searchlight use, since no account is taken of the factor which involves the smallness of the crater area, and hence the greater intensity of light immediately in the region of the focus. In other words, two carbons may give an equal quantity of light, but the one of smaller area is of much greater value for a searchlight.

Summary

To summarize the principal points that have been discussed:

* Not reproduced.

A brief outline has been given of the general processes used in the manufacture of carbons and carbon products. A discussion of the conditions governing the choice of the proper carbons for a given current has been given together with the operating characteristics of the arc, and of the positive and the negative carbons.

It has been pointed out that satisfactory operation very largely depends upon proper co-ordination of lamp feeding ratio and carbon sizes.

As a result of these observations, a complete new line of searchlight trims has been developed, the advantages of which are well shown in the appendix. These trims are well suited to the present lamp provided the feeding ratio be properly chosen.

Several notes on various operating conditions such as the control of the crater formation and the effect of intermittent operation on burning ratio have been given which it is believed will be helpful in securing satisfactory service.

A brief description of the new flame cored searchlight developments has been given.

A very convenient method for measuring the total effective light flux received by the mirror has been described.

In conclusion, we desire to express our appreciation of this opportunity of presenting the more recent developments in searchlight practice. May I add that the National Carbon Company has been patriotically writing off a loss of about $5000 a year for a number of years on its searchlight account, with but very little hope of return in order to supply the United States Army and Navy with its searchlight carbons.

Appendix

N. C. Company Standard Searchlight Carbons

Size of Searchlight	Current	Arc Voltage	Carbon Sizes		Burning Ratio
			Positive	Negative	
Inch	Ampere				
9	10	46–49	13x120 mm	8x110 mm	1–1
12	20	48–51	16x140 "	9x130 "	"
18	35	50–54	16x180 "	9x160 "	"
24	50	50–54	19x250 "	10x230 "	"
30	80	55–59	25x250 "	11.5x230 "	"
36	120	58–62	28.5x250 "	13x230 "	"
60	200	67–75	35x300 "	16x300 "	1.35–1

Improvements that have resulted from making both carbons smaller and copper coating the negative.

Small positive:

1. Smaller angle of depression in beam.
2. Better focusing condition.
3. Less lateral arc wandering.
4. Quick rise to full candlepower.
5. Better light steadiness.
6. Higher average brightness facing mirror.

Small negative:

1. Better crater exposure toward mirror.
2. Well pointed tip.
3. Improved arc stability.
4. Electrical steadiness.
5. Smaller shadow from negative and more light on mirror from crater.

Increasing length of arc:

1. Higher arc voltage.
2. Smaller shadow from negative and more light on mirror from crater.
3. Increased arc and power input for a given current.

Increasing amount of current:

1. Increased amount of light from beam.
2. Greater percentage of energy converted into light waves.

Total increase in mean candle power is 25 to 30 per cent.

THE COAST ARTILLERY WAR GAME OF THE STATE OF NEW YORK

By Lieut.-Col. W. IRVING TAYLOR, C. A. C., N. Y.

In December, 1913, the writer, Major Winfred H. Roberts, C. A. C., N. Y., and Electrician Sergeant, 1st class, William Arnsperger, C. A. C., N. Y., visited the Coast Artillery School at Fort Monroe for the purpose of receiving instruction and advice in regard to the construction of a coast artillery war game.

Although work was begun about March 1, 1914, owing principally to financial difficulties, the construction of the apparatus has but just been completed.

The Coast Defenses of Long Island Sound were selected as our terrain for the reason that it is there that our companies hold their annual target practice.

The board is 36 x 32 feet in size and comprises the area between a line drawn east and west through New London, Connecticut, to the north; the north shore of Long Island to the south; a line running north and south through Orient Point to the west; and a line running north and south just outside of Montauk Point to the east. All the land areas are constructed of white pine lumber.

In the progress of the work we have perfected what we believe to be several novel features.

The addition of a small motor, with suitable shafting and gears, to the miniature searchlight described in Major Chamberlaine's pamphlet, made it possible to traverse the lights electrically and to place the control apparatus for each miniature searchlight at the fire commander's or fort commander's station, where it tactically belongs.

The miniature searchlight controller designed for this war game consists of an arrangement by means of which the four-volt motors on the miniature searchlights may run at variable speed in either direction from a 110 volt D. C. source.

The control panel, shown on Fig. 1 (at the front of the illustration), consists of a slate base, drilled at the corners

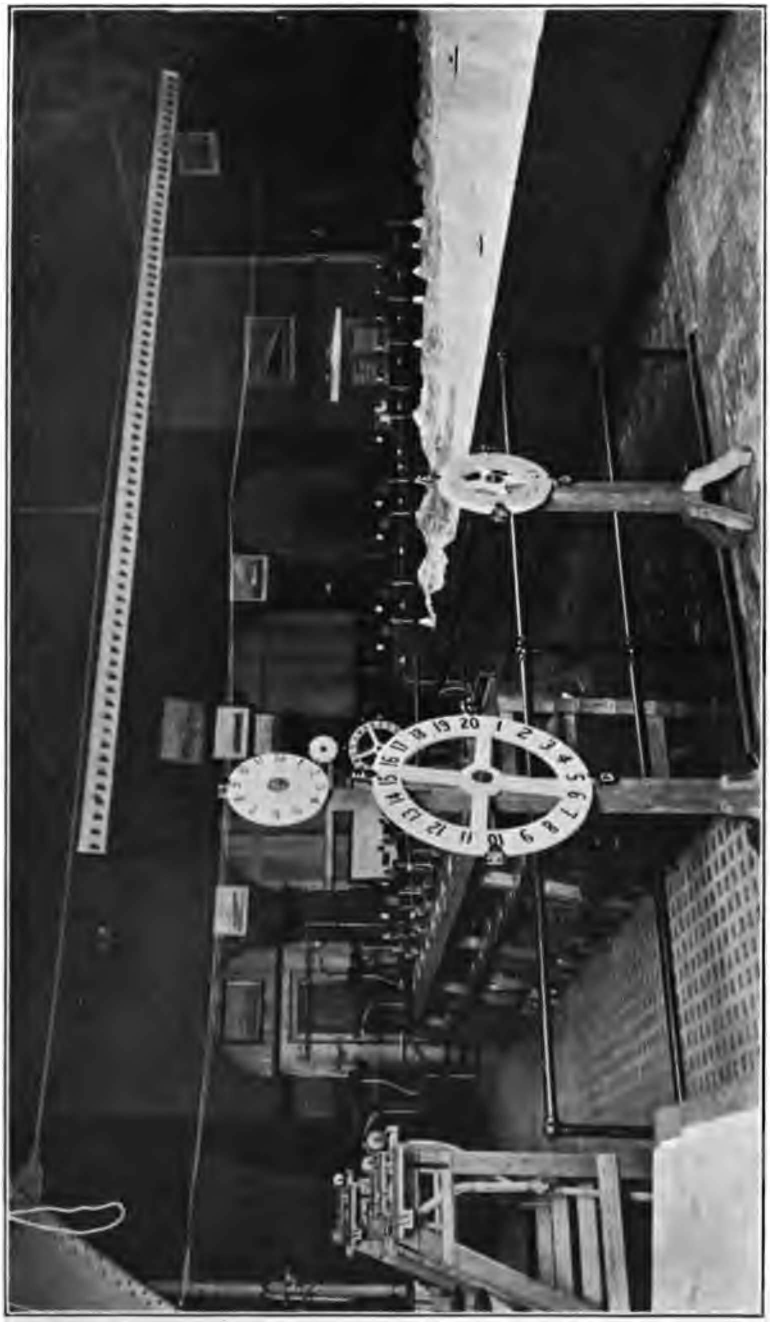
for mounting screws, having upon it a Ward Leonard 62 ohm fixed resistance and a 75 ohm variable resistance, with bare space on the wire upon which an adjustable slider may be moved. Also mounted on the panel is a small pole changing switch; a D. P. S. T. knife cut-out switch; and a special push-button operating switch, constructed like a spring knife switch, in order to prevent arcing. A miniature lamp, when the power is on, furnishes sufficient light for the operator to

Photograph by Underwood and Underwood. 1772

FIG. 1.

work the controller without danger of shock. The various parts of the apparatus are wired in series and the whole is in series with the motors on the miniature searchlights.

The apparatus on the flat-top desk (shown in Fig. 1) provides a method of controlling the amount of illumination and the length of the beam of each miniature searchlight, thus simulating the effect of varying atmospheric conditions upon searchlights in actual practice. It consists of a slate base carrying fifteen complete control circuits, each provided with a Ward Leonard enamelled fixed resistance unit, Edison base mounting, in series with a Ward Leonard enamelled variable resistance having a bare space on the wire on which



Photograph by Underwood and Underwood.

FIG. 2.

1778

Photograph by Underwood and Underwood. Fig. 3. 1774

an adjustable slider may be moved. By means of this apparatus the 1.8 ampere, 6 volt lamps in the miniature searchlights may be regulated from full candle-power to a low degree of illumination, as desired. Current at 110 volts is taken from the street mains.

Each miniature searchlight lamp is turned out or on by means of a push switch on the flat-top desk. Upon the desk there is also a miniature pilot lamp with Western Electric lamp cap of the same characteristics as the lamp in the miniature searchlight. These pilot lamps burn with the same brilliancy as the lamps in the miniature searchlights and keep the operator at the desk advised of the action of each miniature searchlight lamp upon the board.

General illumination of the war game is provided by two border light reflectors suspended above it. Each reflector carries four distinct circuits controlled by separate switches and dimmers on the panel-board shown in Fig. 1. The lamps in each circuit are tinted a different color. Any combination of these four colors may be made by means of the switches and the intensity of the colors may be regulated by means of the dimmers. This arrangement permits of a great variety of light effects and makes it possible to simulate night, dawn, sunrise, noon, etc.

Lamps in pull sockets and supplied with adjustable shades are mounted on each station desk, thus permitting the players to regulate the light on their desks at will, and the lights are so screened as not to interfere with the players' view of the war game board.

SEMI-AUTOMATIC AND UNIVERSAL PLOTTING AND RELOCATING BOARD

By Major HAROLD E. CLOKE, Coast Artillery Corps

The enclosed description, photographs, and working drawings* of a semi-automatic and universal plotting and relocating board have been prepared by me after many months of experimentation in this line of work and were submitted to the War Department for such use as seen fit. The writer believes that there is an urgent necessity and a demand in Coast Artillery Fire Control Service for a plotting board of this character. Especially is such a device valuable where one or more observing stations have been put out of action.

A full sized model has been made by me and is now in the Battle Command Station at Fort Flagler. It has been used and tested by various details. It has been examined by several officers stationed in these Coast Defenses. Most of these officers examined it critically. Various enlisted men, especially plotters, have examined and used it. The opinion of all has been favorable.

Owing to the increased ranges required, the size of the plotting board will have to be increased, even though a reduced scale be used. A scale of 400 yards to the inch is used in the board herewith (radius 58 inches, greatest range 20,000 yards).

Although the mechanical construction of this board has been most difficult without the use of a machine shop and tools of precision, the working model, as shown in the photographs, checks to within 5 yards using a series of several datum points.

The advantages claimed for this board are as follows:

a. It is simple, strong and durable, and has no gears.

b. It is universal for any base line.

c. It is semi-automatic in plotting. (The arms and targ being set, the mere pressing of a button plots the relocated position of the directing point of any battery in the post with reference to the target.)

* Not reproduced

d. It will supply ranges and azimuths for batteries whose observing stations have gone out of action.

e. It is accurate and positive in its work.

f. It is cheap to construct.

g. It is easy to operate and quick in its action.

h. It relieves the plotter of all work except the study of the track of his target and the work of predicting.

i. It is easily and quickly oriented for any base line.

The fundamental principle of this board is the same as in all plotting boards, i.e., the solution of a triangle knowing two angles and the included side. The mechanical application to a particular case was originally conceived when trying to use the principle of the "Pratt spanner" in connection with plotting as well as relocating.

A board designed on exactly similar principles was submitted by me to the War Department in the Spring of 1909. Its description is published in the JOURNAL of 1909 (September-October number). It was then submitted as a fire commander's identification board for rapidly relocating a target for a number of batteries.

The board as now submitted, embodies three radical changes from the previous board. First, offsetting the secondary arm; second, countersinking the offset below the level of the board; third, placing the pivot arm of the platen box above the platen. These three changes permit of the use of any battery on any position of the platen even though it be under the pivot arm, i.e., the "push button targ" for the battery desired can always be reached no matter where located.

The principle of the board reverses the old method, i.e., the target is located at the pivot and not at the intersection of the primary and secondary arms.

Many difficulties were encountered to adapt this principle mechanically so that it would fulfil other requirements, i.e., so that it could be used with horizontal base, vertical base primary, vertical base secondary, and so that any battery in any position could be plotted on any position of the board without any of the metal work interfering. This last presented many mechanical difficulties in order to retain "simplicity." The use of the offset on one arm, the drop or countersinking of the offset, and locating the platen pivot above the platen have all accomplished these difficulties. There are no dead angles on the board.

The primary arm being of tempered steel, and the targ of case hardened steel, most accurate and positive intersections are obtained. The targ also moves on a pivot, thus permitting its vertical edge to come against the vertical edge of the primary arm *squarely* and *perpendicularly*.

The model that I have finally evolved is far from a finished product. Allowances in accuracy, and ease and rapidity of operation should therefore be made.

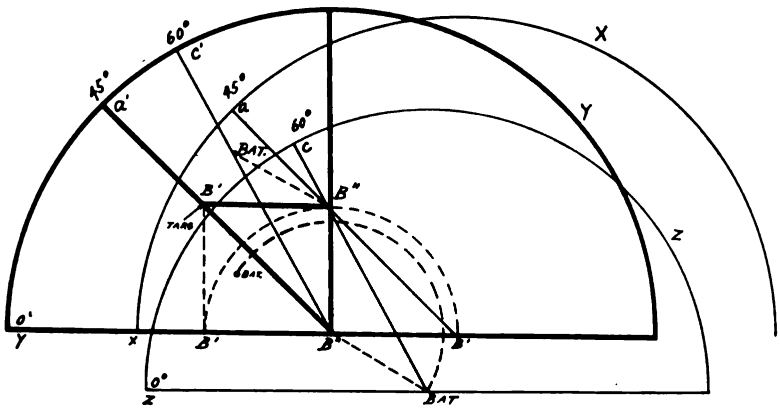


FIG. 1. 1776

LIGHT LINES ILLUSTRATE METHOD OF PLOTTING BY THREE-ARM THREE-CIRCLE METHOD: HEAVY LINES TWO-ARM ONE-CIRCLE METHOD

Note: Heavy vertical line should be indicated as line B''-b.
On line B''-b at intersection of line BAT-c, B'' should be B''_1.
On line B''-c', BAT should be BAT_1.
On line B''-a', B' should be B'_1.
Below line B''-a' and between B'' and B'_1, BAT should be BAT_2.
B' to left of B'' (center of azimuth circle Y) should be B'_2.

The scale of this board is 400 yds. to the inch. The base lines used for test averaged 1600 yds. The longer the base line the greater the accuracy. With accurately made and well fitted metal parts, using a 2000 yard base line, this board should check to 10 yards for ranges as great as 30,000 yards.

The geometrical principles involved in this board are perhaps the most easily explained by referring to a diagram. In Fig. 1 are shown: a base line, B', B'', and a battery (BAT), each with its respective azimuth circle X, Y, and Z.

PROBLEM

Case I. If we plot the target with the "three-arm three-circle" method as is practiced at present, it will be located at

the intersection of the lines B'-a and B''-b (the gun range and azimuth being read on BAT-c and circle Z, respectively).

Case II. To plot by the "two-arm one-circle" method, let us revolve B' and BAT 180 degrees on B'' as a pivot, as shown in Fig. 1. B' now occupies the position B'_2 and BAT is at BAT_2.

Required the range and azimuth from the battery (azimuths from base ends being as before: B′, 45°; B″, 90°).

ANSWER (CASE II)

Set the arms as shown in heavy lines. Move the base line B'_2-B'' along the line B''-b until B'_2 intersects B''-a', keeping B'_2-B'' parallel to its original direction.

The battery is moved in its relative position with the base line and BAT_2 is now at BAT_1.

The range from the target at B'' to the battery at BAT_1 is read by swinging the primary arm B''-a' to c', intersecting the battery, and the azimuth is read on the same circle Y.

Description

The board consists of the following parts (see Fig. 2):

a. A wooden table 1½ inches thick in the form of a semicircle. The board may be more convenient if it subtends an 110° arc. (Radius, 58 inches; offset between "base line" and lower edge of "base arm," 9 inches.)

b. A metal azimuth circle, slotted to receive a sprocket or bicycle chain consisting of 360 links, each link being 1 inch long and representing one degree. The chain is actuated by two sprocket wheels and two cranks underneath the board.

c. A metal yoke is riveted to a metal base arm and is bolted to a metal reinforcing plate below the board which are bolted to the metal azimuth circle.

The depth vertically between the top of the lower plate and the bottom of the upper plate of the yoke is 1½ inches.

The depth from the pivot to the rear is 8¾ inches. The above metal parts are of bronze. The azimuth circle, base arm, yoke, and reinforcing plate thus form the metal skeleton of the board, and expand and contract equally. They merely rest upon the wooden table or board.

d. Pivotted to the metal yoke are two metal arms of nickel plated tool steel 1½ inches wide, ¼ inch thick. One is pivotted on the upper face of the lower part of the yoke, and

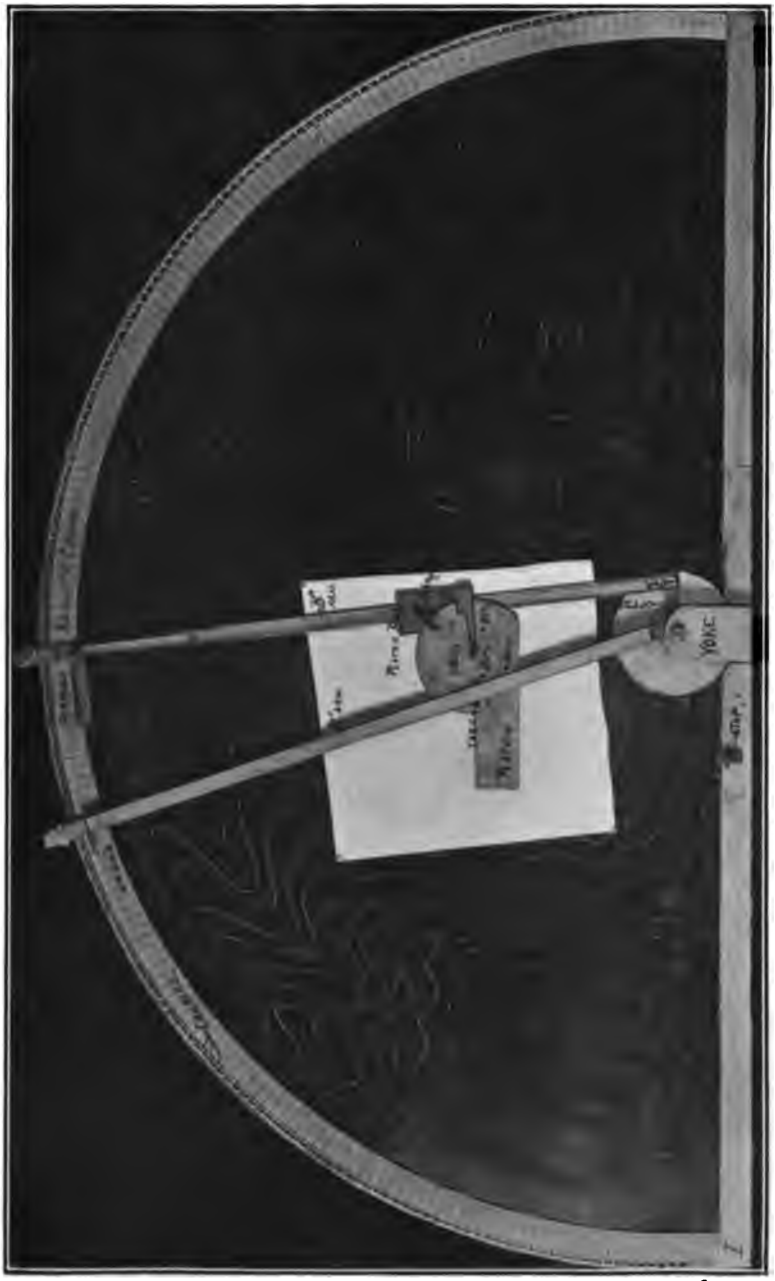


FIG. 2.

the other is pivotted to the under face of the upper part of the yoke. Both arms are provided with clamps to the azimuth circle.

The B″ arm is offset from the edge to the center of the pivot.

The B′ arm is of square cross section with a pivot in line with the fiducial edge of the arm. The offset in B″ arm is countersunk below the surface of the board to avoid interference with the platen box and platen.

e. The platen consists of a piece of cast aluminum 3/32 inch thick around the circular edge one inch from the circumference, and 7/16 inch thick in other parts. Its shape is as shown in Figs. 2-6. The radius is equal to 1 inch plus

FIG. 3. 1777

the length of the base line. Ball bearings are provided underneath to reduce the friction of sliding.

A targ is provided for the platen, to fit in the hole which represents the primary station. This targ is made of steel case hardened, and moves on its own pivot.

f. The platen box, made of steel or bronze, is slotted underneath to fit exactly on the secondary arm and is provided with a clamp so that when the box is brought against the stops on the secondary (B″) arm and the base arm, the platen becomes fixed to and a part of the platen box and when the latter is slid along the B″ arm, the box remains parallel to itself, thus fixing the parallel relations of the batteries located on the platen. The pivot for the platen box is fastened to an overhanging steel arm which is a part of the platen box. This permits of plotting when the battery happens to come in prolongation of the base line. Friction plates are inserted

on the slide guides of the platen box and can be replaced when worn. Ball bearings are provided underneath the box.

g. An adjustable base line stop is provided on the base arm.

h. An accessory plotting device called the "offset plotter" is shown in Fig. 3. This permits the plotter to plot a target away from the range arms and working parts.

i. A stop for the platen box is provided on the secondary arm.

j. A stop is also provided underneath the platen which comes against the base line stop.

k. Sub-scales for the two arms are provided for setting in azimuth.

l. Auto-targs (push buttons) are provided in the platen.

THE OFFSET PLOTTING DEVICE

This consists of a sliding box and transparent celluloid arm fastened to it. This box slides on the secondary arm independent of any other work and is brought up against the platen box when the arms and platen are set. The plotting is done by the use of a pencil or separate targ.

Additional B′ and B″ arms and platen and platen box are provided for right handed base lines. They are the reverse of the left handed arms.

The location of stations and batteries on the platen are accomplished by constructing it as you would a map. The secondary station should be at the center of the platen circle for horizontal base and the primary for vertical base. The locations on the platen are reversed 180 degrees by revolving the map on B″, to the left for left handed base lines, and to the right for right handed base lines. Either arm, therefore, may be considered as primary or secondary. The location of a battery is always at its range and azimuth from either observing stations on the platen according to the scale of the board.

It is essential when constructing this board that the centers of the yoke and pivot of the platen box are in the same line perpendicular to the plane of the board. The edges of the secondary arm should also be constructed with great nicety as their being exactly parallel and straight is essential to accuracy.

To Orient the Board

1. Insert the platen that is graduated for the battery to be used. Release the base line stop and bring the platen box to the stop on the secondary arm.

2. Operate the crank until the azimuth of the base line in whole degrees appears in the azimuth slot which is in prolongation of the base line.

If the base line be left handed (B″ on left of B′, facing the field of fire), the azimuth of the base line will be set on the left of the board facing the normal from the yoke. If right handed, on the right of the board.

3. Set the primary arm at the exact azimuth of the base line.

4. Revolve the platen on its pivot until the targ intersects the primary arm, being careful to keep the platen box against the stop on the secondary.

5. Bring the base line stop against the platen stop and clamp the former. The board is now ready for use.

Operation of the Board

TO TRACK HORIZONTAL BASE

1. Release platen box clamp.

Bring the platen box against the secondary arm stop.

Bring the platen stop against the base line stop.

Set primary and secondary arms at their respective azimuths and clamp.

See Fig. 3. These operations are done simultaneously.

2. Clamp platen to platen box and slide platen along secondary arm until targ intersects primary arm.

Press the button or auto-targ that corresponds to the battery you are plotting for. This is the relocated position of the battery with reference to the target at the pivot of the board. See Figs. 4 and 5.

Unclamp platen and bring platen box and platen to their respective stops for another operation.

Predictions are made in the usual manner. The azimuth and range of the predicted point are determined by placing the primary arm over that point using the auxiliary targ and reading the range and azimuth on it.

The moving parts of the board are on ball bearings.

The platen and platen box are brought to the yoke for each operation in plotting. The plotting is always free from

any interference of any metal parts, arms, etc., except the primary. As soon as the auto-targ is pressed, the primary

FIG. 4. 1778

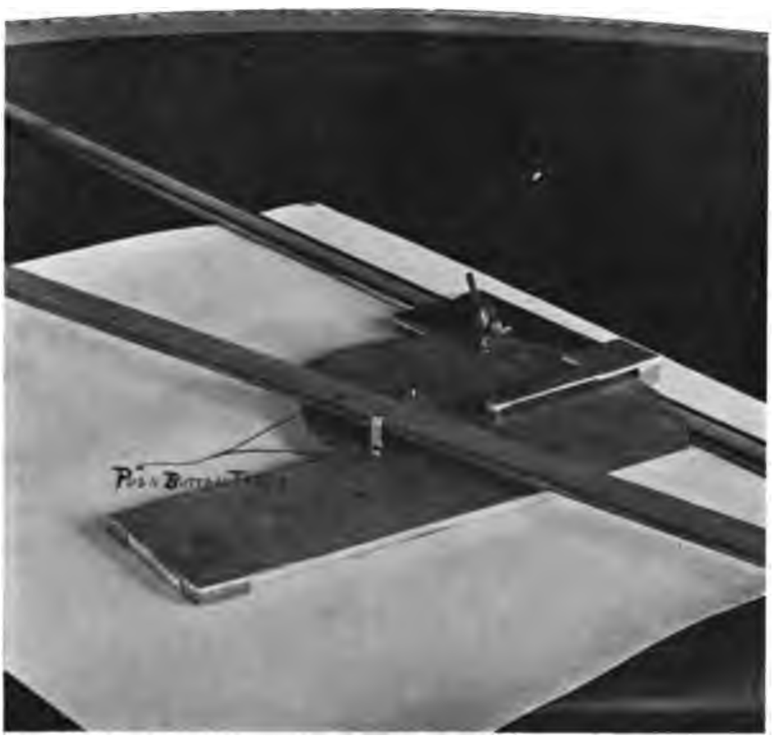


FIG. 5. 1779

arm should be moved to one side, the platen in the mean time being moved to the rear. This gives the plotter plenty of room in which to predict and study his track.

3. The board requires three operators and one plotter. The operators consist of two armsetters and one platen setter. The plotter has nothing else to do but predict and read the range to be sent to the guns. In case of mortars, No. 1 armsetter reads the azimuth.

TO TRACK VERTICAL BASE—PRIMARY

Proceed as in previous case, but omit the setting of the primary arm for azimuth. Both range arms now become azimuth arms. The azimuth of the target is set on the primary arm (offset arm). The azimuth of the target is set on the primary arm. The platen is clamped and moved along the arm until the platen box intersects the range. The auto-targ on platen corresponding to its vertical base position is now pressed and the operations are as before.

TO TRACK VERTICAL BASE—SECONDARY

Proceed as in horizontal base, omitting setting of primary arm and substituting setting of platen box at the range on secondary arm. The targ may be taken out of its receptacle on the platen when tracking vertical base.

TO TRACK FOR MORE THAN ONE BATTERY

Arms and platen being set and clamped, press as many auto-targs as desired. These will be relocated positions of the batteries that they represent. The primary arm may be moved over each position of the various batteries and the ranges read immediately if desired.

TO PLOT BY MEANS OF THE OFFSET DEVICE

a. This is shown in Figs. 3 and 4.

When the arms and platen are set and clamped as shown in Fig. 3, the offset plotting is as indicated at "A."

b. To read the range of a predicted point, set the offset slide at the intersection of the predicted point.

c. Move the platen box to the offset slide.

d. Move the primary arm over the battery on the platen.

e. The range and azimuth are now read on the primary arm.

RIGHT HANDED BASE LINES

When using right handed base lines, the arms, platen, and platen box of the opposite shape should be used in order to have the advantage of the offset arm away from the plotted positions.

A board constructed for a left handed base line will also work for a right handed base line. The advantage, however, of having the offset of the secondary arm out of the way of the plotting is evident.

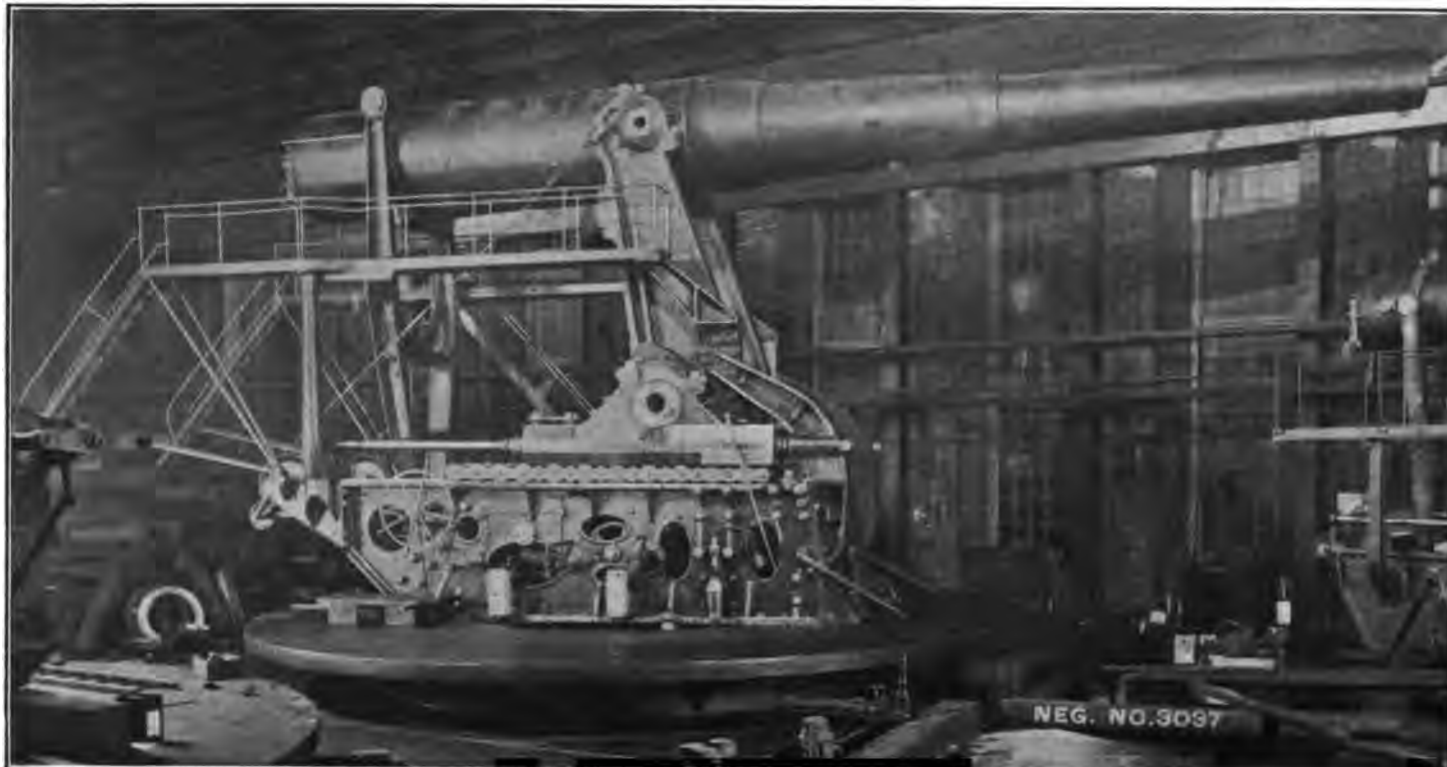
NOTE.—The length of the offset on secondary arm should be at least equal to the distance from the primary station to the battery.

FIG. 6. 1799

A thimble for pressing the button of the auto-targ when it happens to be near the pivot arm is also provided.

For batteries at distances greater that 2000 yards from either B′ or B″, larger platens would have to be constructed.

A special platen is shown in Fig. 6 for a battery at a distance of 10,000 yards from the primary station. When vertical base is used, the operation is as before.



THE U. S. ARMY 16-INCH B. L. R. MOUNTED ON ITS CARRIAGE 1781

(228

 1783

THE U. S. ARMY 16-INCH B. L. R. MOUNTED ON SPECIALLY CONSTRUCTED CARS FOR RAILROAD TRANSPORTATION

PROFESSIONAL NOTES

STEREOPHOTOGRAMMETRIC PHOTOGRAPHS OF THE TRAJECTORY OF PROJECTILES

By ANDREAS VON HUBERTH, C.E.

Translated* from the German for the JOURNAL U. S. ARTILLERY
by Lieutenant LEE R. WATROUS, Jr., Coast Artillery Corps

The object of this new method is to ascertain the ballistic elements of the trajectory without any calculation.

As yet there is no exact theory of the trajectory because so many influences assert themselves that their consideration strictly mathematically is impossible. It is true, the end is achieved approximately by empirical formulæ; but it is plain that a method is desirable, by which with only a few shots, or perhaps with only one, an exact knowledge of the form of the trajectory and of the velocity of the projectile as well as of the angles of inclination of the tangents to the trajectory at every point and even respecting the axial rotation of the projectile, may be obtained.

The photograph is taken during darkness, in which the projectile, as with the method of Professor Neesen, is made visible by a brilliantly illuminating tracer containing magensium and its trajectory is obtained with the aid of the stereophotogrammeter.

Although the stereophotogrammeter may be known to many readers of the *Artilleristische Monatshefte*, still some details respecting stereogrammetric photographs may be presented.

The stereogrammetric apparatus consists of two entirely similar photographic cameras with like objectives, like focal distances, and like plate ranges. The cameras stand at the same height and the plates in the same plane, but the distance of the cameras from one another is optional. In Fig. 1 the arrangement of the pair of cameras is diagrammatically shown. If we designate the normal width between eyes by $b = 65$ mm., a ratio number by $N = 100$ to 2000, and the distance between the optical axes of the different apparatus of the stereophotogram by a, then we have the following equation

$$a = Nb$$

The negative is made accordingly with the extended eye width a. After developing plates I and II, these are observed in the stereocomparator. By this it will appear that n is a ratio-number between 1 and 4. The plates are therefore seen with an eye width extended to b'.

Further, let

$$\delta = \frac{1}{3400}, \text{ the ratio corresponding to the angle of sight.}$$

* Translation edited by Captain Samuel G. Shartle, Coast Artillery Corps.—*Editor*.

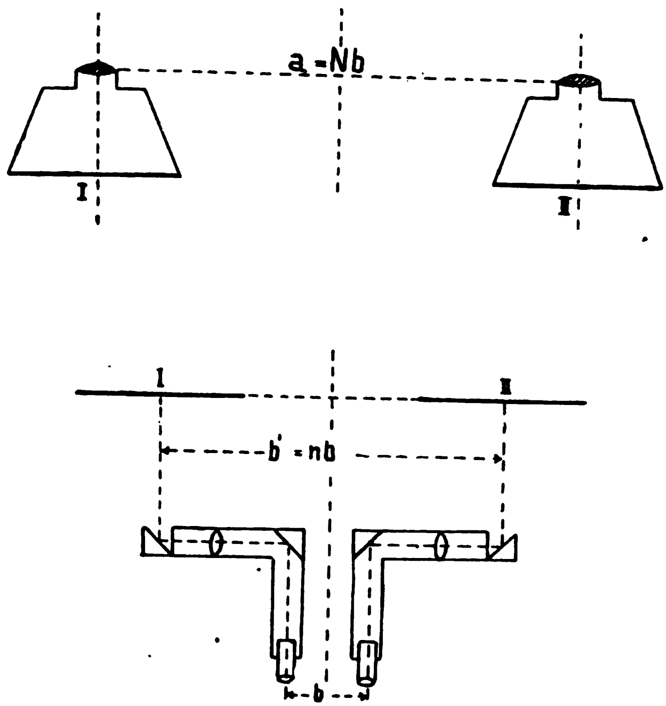


FIG. 1.

1783

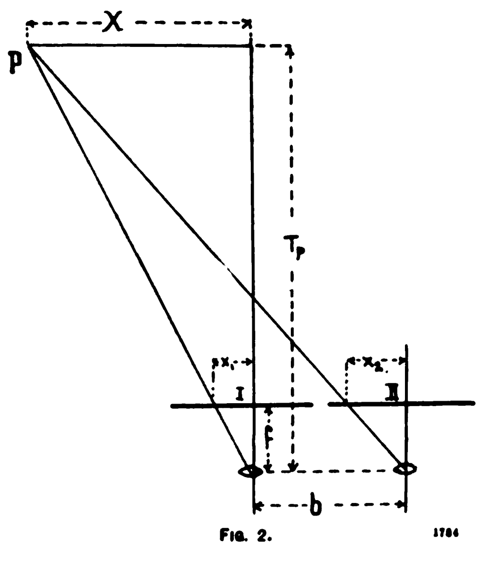


FIG. 2.

1784

f, the focal distance of the stereoscope.
F, the focal distance of the photographic camera.
T_p, the distance of the vertical plane through the point P (Fig. 2) from the centers of the lenses of the stereoscope.
Δ_t, the shortest line that can still be measured accurately at the distance t.

$$\Delta_t = \frac{t^2 \times \delta \times f}{a \times F}$$

For example, let
$F = 180$ mm.
$f = 30$ mm.
$a = 10$ m.
$t = 100$ m.
Then,

$$\Delta_t = \frac{100^2}{10} \times \frac{1}{3400} \times \frac{30}{180} = \frac{1000}{20400} = 0.05 \text{ m.}$$

That is, we can still accurately differentiate 5 cm. at the distance of 100 m.

On plates I and II (Fig. 2) the co-ordinates of the point P are designated by x_1, y_1, and x_2, y_2; and the true deviation of the point P from the center of the left lens by X_1.

$$X_1 = T_p \times \frac{x_1}{F}$$

but

$$T_p = \frac{F}{x_2 - x_1} \times a$$

hence

$$X_1 = \frac{ax_1}{x_2 - x_1}$$

and the height of the point P over the plane of sight,

$$Y_1 = \frac{ay_1}{x_2 - x_1}$$

to which is to added the absolute height of the instrument.

The co-ordinates x_1, x_2, and y_1 are calculated from the center of the plates.

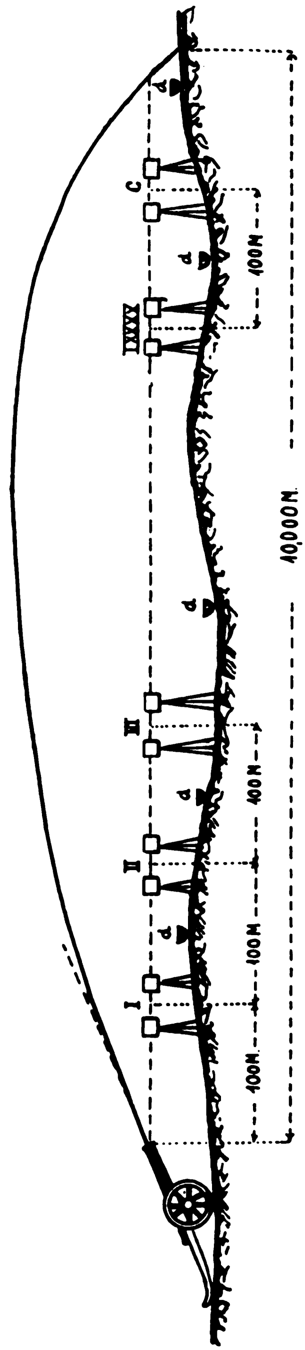
Now we can take up the problem proper.

As can be seen from the general arrangement (Fig. 3), plates are placed at the distance b' from one another so that

$$b' = nb$$

The whole range is divided into sections 100 m. in length and in each section a photogrammetric apparatus is set up. The distance may be as much as 10 km.

The individual pairs of cameras of each photogrammeter are set up at a distance $a = 10$ m. It is advisable, but not absolutely necessary, to set up the stereophotogrammetric apparatus at the same height and in the same plane. At the middle of the trajectory, some apparatus must of course be set at a considerable angle in order to make it possible to take the apex of



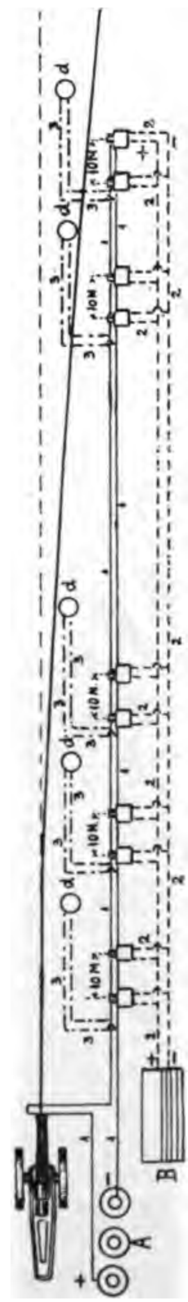
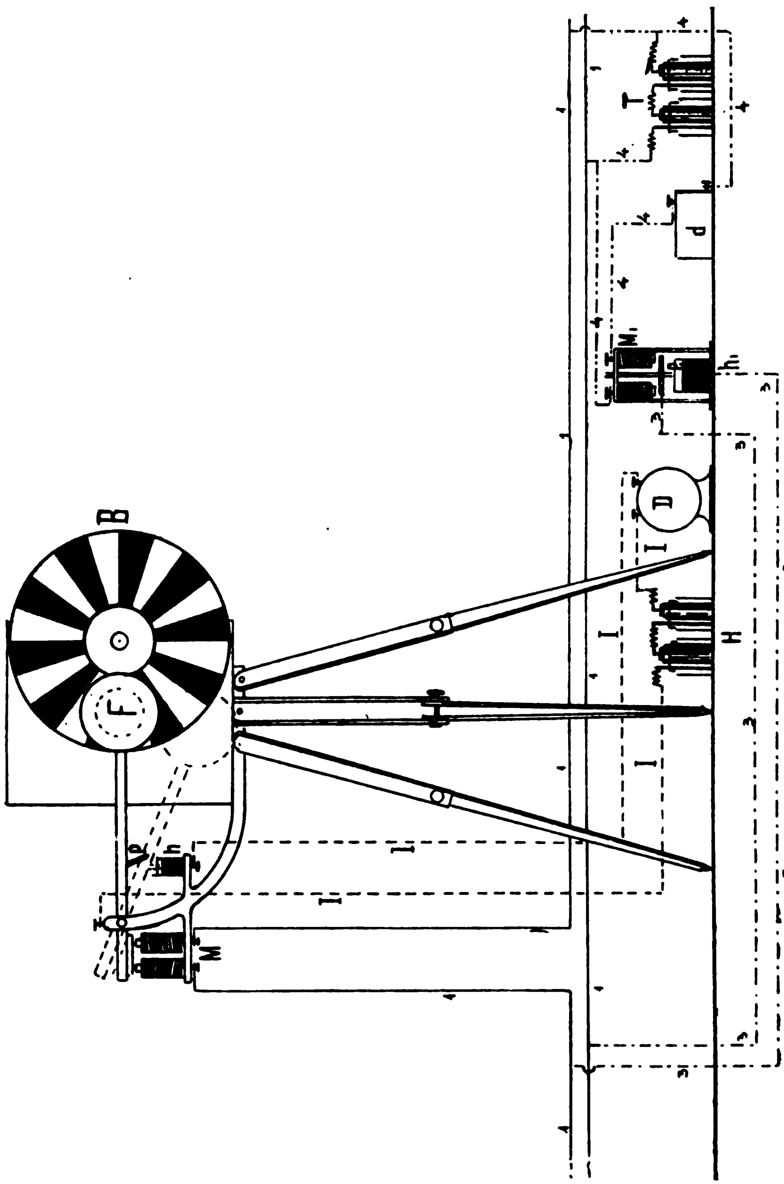


FIG. 3.

1784



1786

FIG. 4.

the trajectory. It is only necessary that the cameras belonging to a stereoscope be placed parallel to one another, hence at the same angle of inclination.

The current from battery A flows through circuit *1* to the muzzle of the gun and from there to each photographic apparatus. Each camera has a main shutter, which is kept closed by an electro-magnet, as shown later, and is opened only by breaking the lead *1*—accomplished by firing the gun. Hence all main shutters open at the same time; since, however, the photographing takes place in the dark, only the self-illuminating projectile can make a chemical impression on the plates. From the exactly regulated central clock *B*, circuit *2* goes to each apparatus and actuates its revolving instantaneous shutter (Fig. 4).

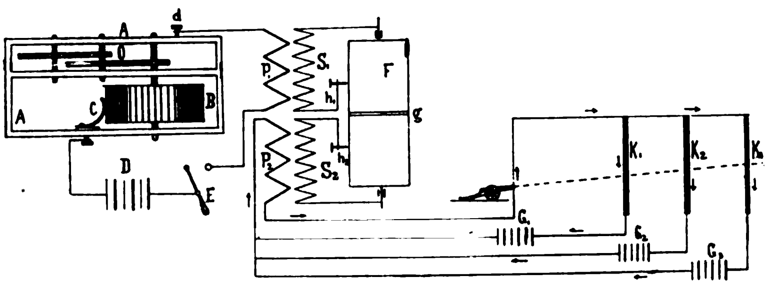


FIG. 5. 1787

All instantaneous shutters accordingly operate synchronously. The drum *B* has a certain number of slotted openings and on its periphery likewise numerous metal sectors. The number of slots is determined by the desired speed of exposure. If, for example, there are 100 slots on the drum, and, of course, also 100 covered parts, and if the drum makes one revolution per second, then 100 exposures per second can be made with the drum *B* rotating before the objective, the duration of which will be 0.005 seconds each.

If it be possible to set up the stereoscopic apparatus at a distance of 30-50 m. from the trajectory, then the time of exposure can be reduced to 0.0005 seconds. The whole arrangement of the rotating shutter is similar to that of an induction clock. The illuminations are registered by means of the sectors of the drum *B* on a rotating drum not shown in the drawing. This drum is located in the induction clock *D* (Fig. 4).

The induction clock is modeled after the Siemen induction chronograph with this difference that an exactly regulated clock, which indicates the desired time interval on a rotating drum, is switched in.

In the metal frame *A* (Fig. 5) the drum *B* rotates, driven by the precision clock works *O*, with uniform speed. In the drum *B* 100 insulated sectors are inserted, so that the spring contact brush *C* at each turn of the drum causes 100 current impulses. According to whether the drum makes 10 or 100 revolutions per second, the number of impulses per second is 1000 or 10,000.

As soon as the drum *B* has attained an uniform speed, the current from battery *D* is turned on by means of the switch *E*, while the same current fires the gun also. The current from battery *D* goes through the brushes

C, through the drum B, and thence to the binding post d and the primary coil of inductor P_1. By the primary current impulses a current is induced in the secondary coil of the inductor S_1, which appears at the platinum point h_1, and from here jumps to the quickly revolving drum F.

The jump spark of the secondary coil S_1 will therefore leave an impression every 1/1000 or 1/10,000 of a second on the sooted drum F. The drum F is cut through the center and one-half divided from the other by an insulating strip g, so that the induced current of the timer can affect only one part of the drum.

The frames K_1 K_2, K_3 . . . . set up in the pathway of the projectiles together with their own respective batteries G_1, G_2, G_3 . . . are connected in parallel to the primary coil P_2 of the second inductor, by which at every current impulse a current is induced in the secondary coil S_2. This is discharged through the platinum point h_2 on the second half of the drum and thus registers the time intervals of the movement of the projectile.

In place of the sooted drum, a drum covered with a film can be rotated. In this case (the apparatus must be kept closed in the light) the mark of the spark will appear after developing as a black point on a white background.

If the induction clock be used only for measuring time, as in the stereophotographing of the trajectory of the projectile, the second inductor may be dispensed with.

The procedure then is as follows: First the rotating shutters by means of the central clock B and the lead *2* (Fig. 3) will be brought to the same number of revolutions and then the shot fired. This breaks the circuit *1* (Fig. 4) and the main shutters F are opened, since the magnet M releases them. Through this means, however, the platinum point p drops into the quicksilver container h and closes circuit I of the local battery H. But circuit I is in permanent connection with the sectors of drum B and records thus the number of exposures and also the elapsed time on the drum of the induction clock D.

When the projectile has passed an apparatus, the main shutter should be closed. This is accomplished by placing diaphrams d further out and outside of the field of the exposure (Fig. 3), the current through which is broken by the effect produced by the air currents of the projectile. In this way, as shown later, circuit *1* is restored, manget M (Fig. 4) again closes the shutter F and immediately circuit I is broken.

As is to be seen from Fig. 4, the diaphram d is connected with the battery T and the electro-magnet M_1. This connection provides circuit *4*. As soon as the diaphram d is torn, the magnet M_1 permits the platinum point p_1 to fall, and thus the quicksilver contact h_1 made and circuit *3* closed. Circuit *3* is, however, a part of circuit *1;* hence circuit *1* is closed by means of battery T between *3* and *4*.

If it is not desired to operate the main shutter automatically, it can be done by hand; only then a lead must be run from battery H to the magnet M and this circuit closed by a switch after the passage of the projectile.

The rotating shutters turn therefore further; but neither an exposure, because of the closed main shutter F, nor a time registering, because of opening circuit I, takes place.

The trajectory of the projectile will be shown on the plate as a broken line (Fig. 6). The greater spaces correspond each to a period of exposure,

for example 1/200 seconds, while the small breaks show the rotation of the projectile.

Finally, it may be noted that the illumination of the projectile should be according to Professor Neesen; that is, the projectile is bored obliquely on the side and a very actinic mixture of magnesium is placed within, which is ignited by the flame encircling the projectile.

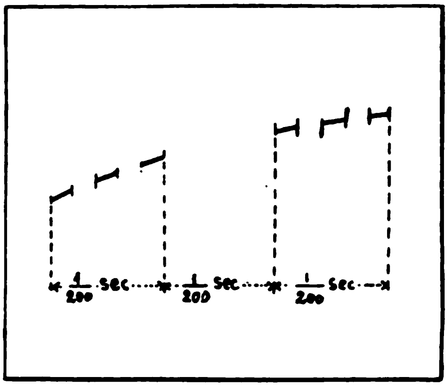


FIG. 6. 1788

With a 10 g. mixture a trajectory of 5000 m. can be taken, such a small weight that the ballistic factors are scarcely influenced or a very insignificant influence is exerted in comparison to other effects, i.e., side wind, height of flight, nearby hills, unlike powder effects, etc.

—*Artilleristische Monatshefte.*

THE DARDANELLES

Had the expedition against the Dardanelles a reasonable chance? Most people will probably agree that it had not, as at first conceived. The attempt to force a passage by ships alone undoubtedly flew in the face of the accepted teaching of history. We had to guide us the local experience of Duckworth in 1807 and Hornby in 1878, which went to prove that in order to secure the passage of the Dardanelles it was necessary to win and hold the Gallipoli Penisula. Again, to pass the Straits involved a battle of ships against forts, and the best opinion seemed to be that forts would win in such a contest. That was the view of Nelson in 1794 and of Moltke—in connection with this very question of the Dardanelles—in 1836.

The bombardment of Alexandria in 1882 was, as it happened, successful; but those who had studied the details had come to the conclusion that it was in reality a very remarkable proof of the superiority of forts against fire from the water. The Egyptian guns were badly mounted and very badly served, but not more than three were put out of action by direct hits. If the forts had not surrendered, twenty-eight of their guns could have been brought into action next day, when our fleet was practically destitute of ammunition. The difficulty of ships attacking forts was accepted in the Spanish-American war and in the Russo-Japanese war, and it was as near being an axiom as any military doctrine in the books. Lord Sydenham,

a very high authority, considered that the advantages of the fort had increased under modern conditions.

Why, then, did we enter upon so heterodox an enterprise? The answer seems to be that there was still an unknown X in the problem—the effect of the latest long-range naval guns and of aerial reconnaissance. It remained to be seen whether these would not alter the situation—whether the forts at the entrance could not be destroyed by long-range fire from the outer sea, and the forts at the Narrows by indirect fire from the Gulf of Saros. On the whole the probabilities leaned against success. Mobile howitzers and concealed land batteries make it very difficult to tell when guns are silenced, and the battleship is a terribly good target. But it is impossible to argue that there was not a chance of success, and it is difficult to maintain that when a great end is sought the one chance in ten should not be gambled on. In the history of war countless enterprises have succeeded in defiance of the text-books. The landing at Gallipoli on April 25 was on paper an impossibility. Are we to rule out altogether those undertakings which, in Voltaire's phrase, "are called divine when they succeed and are regarded as chimeras when they fail"? Even in a subsidiary operation it is permitted to take chances, so long as they are genuine chances. In the old days war used to be three parts an art and one part a science. Today it is three-fourths science, but you cannot get rid of the element of art. A bold scheme *may* succeed, and a commander may embark on it in defiance of a great weight of argument, relying upon a certain instinct for the mood and the moment which has brought many wild adventures to victory. The attack by the ships failed. Had it succeeded, it would have been loudly and justly acclaimed. Its failure, even the loss of three battleships, did not embarrass the conduct of the war elsewhere. There was nothing in it which ran contrary to the definition of a genuine subsidiary operation.

But the third question leads us into controversy. An Expeditionary Force was landed to face an enemy fully warned and prepared, strongly posted in very difficult ground, superior in numbers, in guns, and in ammunition. Once the landing had taken place there could be no turning back. It was necessary to go on at whatever cost, and it was necessary to have reinforcements. These reinforcements, say the critics, could only come from troops destined for the main theatre, and their defection must therefore weaken our effort in that theatre.

* * * * * * * * *

It is unnecessary to go through the story in any detail. Suffice it to say that the enterprise was embarked upon in the apparent belief that a narrow channel, flanked by exceedingly powerful forts, protected by numerous submerged torpedo tubes, and characterized by a current that could carry drifting mines on to the bombarding fleet, could be rendered safe for the passage of a fleet by means of that fleet's guns alone. The theory involved a series of suppositions which it is almost incredible that anyone in the least familiar with the technique of naval gunnery could possibly endorse. Long-range naval gunnery, as we have seen in a previous section, can only be effective if in the last resort experienced observers can find the gun-range by marking the fall of the shots that miss. This process can be carried out at sea from the firing ship, because the target lies in an element utterly different from itself, on which each falling shot sends up a visible evidence of its location. But no artilleryman in his senses would dream of attempting to correct the fire of a long-range gun on shore from a position

from behind the gun itself. The point of impact can only be verified by an observer far nearer the target than the gun and in a position well to the right or left of the line of fire. Only one fort in the Dardanelles lent itself to this kind of observation, Sedd-ul-Bahr. Here one ship could fire, and another, lying out at sea on the flank, mark the shot. And accordingly this was the *only* fort that the naval guns subdued completely.

Many other forts were occasionally silenced, but silencing a fort and destroying it are two different things. Each such fort was reoccupied as soon as the firing ceased. Indeed, it would seem to be a military axiom that no fort can be considered silenced until it has been physically taken and its weapons destroyed. This, obviously, is a thing that ships cannot do, and, more important still, the ships were perfectly powerless either to destroy the torpedo tubes or to prevent the sending down of mines upon the fleet. For both of these purposes the occupation of the banks by a military force was essential.

Indeed, the problem has only to be stated for it to be realized that to enable the fleet to pass up the Dardanelles requires the purely military operations of subduing the forts and holding the shores. In these operations, indeed, the ships might have lent the most useful aid. They could have acted as the heavy artillery of the army and supplied such an artillery as no army had ever been supplied with before. The naval guns, directed by observers on shore, if the heights above the forts could have been taken, would in all probability have silenced every fort on either shore of the Narrows with two days of clear weather.

A bombardment, carried on at intervals for a month, produced, with the exception of the fort at Sedd-ul-Bahr, no results at all. Late in March a final attempt was made to repair previous failures. Three ships were lost and no progress was made. The effect of this sustained failure was to give the enemy time to prepare for the military force which, on March 25, the Admiralty announced was present in ample numbers on the spot. It now turns out that, though present, it could not be used. When, then, the attack was finally made on April 25 the enemy had had six weeks in which to prepare for its reception. In February marines had been landed without opposition at Cape Helles and Sedd-ul-Bahr. In April an attempt to repeat the landing resulted in a holocaust of lives. Between April and the present day it has become obvious that an operation of colossal dimensions has now to be carried through. The Navy had been made to attempt the impossible, and it only succeeded in making it *almost* impossible for the land forces.—*Land and Water*.

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SPEECH OF ENVER PASHA, MINISTER OF WAR, IN THE OTTOMAN PARLIAMENT, JANUARY 10, 1916

Translation from the *Osmanischer Lloyd* of January 11, 1916

Gentlemen:

You must know that the great battle of Gallipoli which has been lasting since the 18th of March, came to an end yesterday. I shall not refer to the event prior to that date and which consists in the attempt of March 5th and bombardments without importance. If this battle ended according to my predictions, which I remember having stated to you, it is due

solely to the fact that I have made good use of the forces which our August Sovereign has confided to me, and the result achieved gives me the conviction that I shall employ these forces from now on with more assurance and confidence.

When our enemies began to bombard our batteries at Sedd-ul-Bahr and Koumkale and the adjoining batteries, I happened to be in those regions and I barely escaped from Fort Sedd-ul-Bahr. At the beginning of the action here, as well as at places of the theater of war which were further away, great alarm was caused in Europe even amongst our allies; but knowing thoroughly the means and the defensive works which had been executed at the Dardanelles, I had the profound certitude that the enemy could not succeed either in his attack by sea or in his operations on land which he seemed to have decided upon. When the hostilities began in Europe it was quire natural that a neutral attitude adopted by us would in no wise be tolerated in view of our geographical position, for Russia, one of the important elements of the Entente, could only become strong when the Straits were free. So that when the first cannon shot was fired in Europe, the same causes which had determined us to order the mobilization at the same time obliged us to fortify the Straits with the means at our disposal. It would not be correct to say that these means were numerous and in conformity with the latest demands of military art. This is a truth which it would be useless to disguise, but making use of all the means which we had we did all that was possible and everything was ready in time. Moreover, thanks to the great assistance of the German Empire, we had obtained two large ships and had made our fleet, at least inside the Straits, superior to that of the enemy.

According to my opinion it was impossible for the enemy to force the Straits with his fleet, an assertion which I never ceased to make. The rows of mines, the torpedo batteries and the masked batteries, with which the Straits had been equipped, would always have maintained their activity. It was possible that the enemy, bombarding from an enormous distance, might destroy our principal forts, but that would not have been enough. It would have been necessary to venture up to the mines in order to destroy our batteries protecting our system of torpedoes and masked batteries; but small units would not have been sufficient for this undertaking, because they would have been easily annihilated by the fire from our masked batteries; there remained, therefore, for the enemy only the possibility of making the attempt with dreadnoughts, that is to say, ships which could face our guns of medium caliber. To push these large units into the row of mines meant to play into our hands, for every vessel which would venture that far would undoubtedly have been sunk and the enemy would have lost a large number of his ships. What was the number of these mines and torpedoes? You will permit me not to disclose. All I can tell you is that their number has largely increased since the opening of the route to Berlin.

Supposing that the enemy fleet, by avoiding the row of mines, and passing the channel in front of Tchanakkale and rounding Nara point, had attempted to enter the Marmora, our fleet, although composed of four vessels, would have had a crushing superiority with its heavy cannons against the enemy ships which would have been obliged to pass one by one a difficult point. At a dangerous turn the ships which would be able to use only two of its cannons would have been the target for at least thirty of our cannons firing at a distance of 5 kilometers; a simple calculation shows

that even the most powerful dreadnoughts were condemned to certain destruction if they risked this enterprise. For this reason the first attempt made me smile, and without disguising my thought, I spoke to the Ambassador of the United States of my conviction, and I added the following words: "Our enemies will not succeed in their attempt. For even in case they should become masters of the Straits, they will have to take into consideration that it is indispensable to destroy the batteries. This is in fact what we desire."

Subsequent events bore out my predictions, and the attack after having taken place as I foresaw, was followed by the operations on land which, if examined at close range, give the impression that the Anglo-French forces, even if they brought five hundred thousand men, could not advance far from the Straits. This was natural, because the enemy not having any railways or other natural means of communication, could not support the huge army that was necessary to win a battle on land in order to become the master of the Straits. It is for this reason that we understand that the attacking forces could only land on the Peninsula of Gallipoli and there, thanks to a surprise attack, take possession of the Peninsula and of the Straits; we had made our preparations accordingly. On the 18th of March the enemy began his landing;* and our troops, from the highest officer to the youngest private, did their duty in an exemplary manner, a thing of which we had all been sure. The enemy warships quietly took their fighting positions and bombarded us from a distance beyond the range of our guns. It goes without saying that before an inferno raised by six hundred cannons hurling shells from 7.5 to 38 centimeters, our troops were forced to withdraw somewhat, and the enemy succeeded in his first landing. But as we have seen in the papers and as the enemy realized it himself, this success cost him too dearly.

After this exploit the Anglo-French attempted by a surprise attack to gain Kodja Tchimen Dagh and Altchi-Tepe—points commanding the Straits. This attempt having been doomed to complete failure, the battle drew out in length. The enemy desirous of bringing the enterprise which he had begun to an end, became more and more obstinate. In the beginning we made several assaults to push the enemy into the sea and we threw him back to the shore; but instead of continuing these assaults which had no other result than the flight of the enemy under the protection of his ships, we judged it more useful to let him come up to us. In this way, while the great battles were taking place in the Carpathians and while a big Anglo-French offensive was carried out on the French frontier against the Germans, we hoped to attract a part of the enemy forces in order to thus relieve our allies. Our hopes were fulfilled and we gave our army an opportunity of assisting our friends by gradually drawing to the Dardanelles an Anglo-French force of five hundred thousand men. We sincerely thank the English to have given us the opportunity of helping our allies.

As the official communiques have told us enough about the battles which took place, I deem it needless to refer to them again. I can say only that I have told the Chamber before that in the beginning we were forced to rely upon ourselves, as we were not in a position to waste ammunition in counter attacks after having stopped the enemy assaults, as our ammunition was not abundant. We were waiting for the opening of communica-

* The attack by sea is probably meant, as the landing of troops did not take place until April 25, 1915.—*Tr.*

tions when the English made one more effort and brought a fresh army of a hundred thousand men which they landed north of Anafarta. But if we are to believe their own confession, they showed during this last enterprise an absolute lack of skill. Hence this enterprise too failed; the British were obliged to remain where they had landed and as they had to realize themselves they were forced into a situation which for an army is not very desirable.

In the meantime a German army was coming down the Danube to move against Serbia. At the same time it attempted to establish communications in order to furnish us with ammunition. Believing that it would be more advantageous for us to await the decision of the campaign against Russia and knowing that we could produce ammunition until the end of that campaign, I did not hesitate to comply with the desire expressed by the German General Staff, that the army destined for the Serbian campaign be sent to the Russian front. What followed showed that this decision was correct. For as a consequence the Russian army was beaten and thrown back to where it is at present. Later on the participation of the Bulgarians inaugurated effectively the Serbian campaign. In this manner communications were established. This constituted an advantage for us, but the most important advantage consisted in the fact that thanks to this participation of Bulgaria our first army became free and could be used for other purposes. Those who direct a war must examine and weigh all possibilities. The Bulgarians, it is true, had adopted towards us a sincere attitude. Nevertheless prudence was necessary and we were obliged to maintain an army to face all possibilities, which might come from that side.

As I have told you, the action of the Bulgarians gave us an entire army. The English alarmed by the imminent establishment of communications between ourselves and the Central Powers tried hastily, and before their realization, to come to the assistance of Serbia. This attempt proved to them that it is impossible to be active on two fronts at the same time. But they already made their landing at Salonika, and in order not to admit their mistake, they endeavored to help Serbia and when the Serb army as you know was, owing to the mistake of its commanders, defeated in the mountains, the English were obliged to give up their enterprise. Before such a result the English could only choose one of two things: either persist at the Dardanelles or give up the expedition at Salonika. But to remain at the Dardanelles was impossible. Therefore, following upon the recall of Hamilton, who in spite of his failure was in favor of continuing the action against the Dardanelles, and after the visit of Kitchener, they took their decision. The English knew too well that our infantry was superior to theirs, and that with the opening of communications assuring our wants we would finally have thrown them into the sea. Thus, having suffered the most serious reverses, they were obliged to abandon the Peninsula of Gallipoli which had been soaked with their blood and covered with the corpses of their many colored troops.

However, one must do this justice to the English that fate has been exceptionally favorable to them in this retreat. They are free to congratulate themselves in their Parliament and to glory in this retreat which thereby does not lose its character of a forced retreat and mad flight. We had the intension of taking the offensive after having completed the equipment of our troops with ammunition; but our enemies were in a hurry. Thus I thank God that time and events confirmed my predictions.

Now that we are in direct communication with the German, Austrian, and Bulgarian armies, we can, thanks to the assistance of our allies, put our army upon a better footing, and I can repeat to you with more force and certainty my assurances that with the aid of the Almighty we shall chase our enemies from our frontiers, and we shall be in a position to prevent his violating the territories taken from us by the enemy.

Before closing my words I address the "Fatihs," to the souls of our sublime heroes who sleep upon our frontiers, after having given us today the power to bear our heads high and after having assured to our dear country the security which it enjoys at present. I repeat that so long as these heroes sleep, we shall not let the enemy violate the lands which they defended so valiantly, and I hope now that the nation, never forgetting the sacrifices of these warriors, will express its gratitude by taking to its heart the sons and families which they entrusted to us.

THE BATTLE-CRUISER FIGHT IN THE NORTH SEA, JANUARY 28, 1915

The moment Von Hipper's scouting-cruisers found themselves in contact with Commodore Goodenough's squadron the German battle-cruisers turned and made straight for home at top speed. They had a fourteen-miles start of the British squadron, and Admiral Beatty settled down at once to a stern chase at top speed. The chase began in earnest at 7:30, the Germans, fourteen miles ahead, steering S.E., the British ships on a course parallel to them, the German ships bearing about twenty degrees on the port bow. In an hour and twenty minutes the range had been closed from 28,000 yards to 20,000. Admiral Beatty disposed of his fleet in a line of bearing, so that all guns should bear, and the flagship began to open fire with single shots to test the range. In ten minutes her first hit was made on the *Blücher*, which was the last in the German line. *Tiger* then opened on the *Blücher*, and *Lion* shifted to No. 3, of which the range was 18,000 yards. At a quarter-past nine the enemy opened fire. Soon after nine *Princess Royal* got within range of *Blücher* and the leading ship, that is, two in advance of the one *Lion* had shifted to at 9:14, was now only 17,500 yards away. At twenty-five minutes to ten, the *Blücher*, having dropped somewhat astern, the *New Zealand* got within range of her. *Princess Royal* then passed the *Blücher* on to *New Zealand* and shifted to the *Lion's* second target, No. 3, and hit her severely. So early as a quarter to ten the *Blücher* showed signs of heavy punishment, and the first and third ships of the enemy were both on fire. *Lion* was engaging the first ship, *Princess Royal* the third, *New Zealand* the *Blücher*, while *Tiger* alternated between the same target as the *Lion* and No. 4. For some reason not explained the second ship in the German line does not appear to have been engaged at all. Just before this the Germans attempted a diversion by sending the destroyers to attack. *Meteor*, Captain Mead, with a division of the British destroyers, was then sent ahead to drive off the enemy, and this apparently was done with success. Shortly afterwards the enemy destroyers got between the battle-cruisers and the British squadron and raised huge volumes of smoke so as to foul the range. Under cover of this the enemy changed course to the northward. The battle-cruisers then formed a new line of bearing,

N.N.W., and were ordered to proceed at their utmost speed. A second attempt of the enemy's destroyers to attack the British squadron was foiled by the fire of *Lion* and *Tiger.*

The chase continued on these lines more or less for the next hour, by which time the *Blücher* had dropped very much astern and had hauled away to the north. She was listing heavily, on fire, and seemed to be defeated. Sir David Beatty thereupon ordered *Indomitable* to finish her off, and one infers from this, the first mention of *Indomitable,* that she had been unable to keep pace with *New Zealand, Princess Royal, Tiger,* and *Lion,* and therefore would not be able to assist in the pursuit of the enemy battle-cruisers.

The range by this time must have been very much reduced. If between 7:30 and 9:30 a gain of 10,000 yards, or 5000 yards an hour, had been made, between 9:30 and 10:45 a further gain of 6250 yards should have been possible, even if we suppose neither side to have lost speed, and it is more likely that the Germans lost speed, as two of them were burning, and no injuries to this point were reported to the English ships at all. But there had been two destroyer attacks threatened or made by the enemy, one apparently at about twenty minutes to ten and one at some time between then and 10:40. It is possible that each of these attacks caused the British squadron to change course, and we know that before 10:45 the stations had been altered. Each of these three things may have prevented some gain. Still, on the analogy of what had happened in the first two hours, we must suppose the range at this period to have been at most about 12,000 yards. At six minutes to eleven the action had reached the rendezvous of the German submarines. They were first reported to and then seen by the Admiral on his starboard bow, whereupon the squadron was turned to port to avoid them.

Very few minutes after this the *Lion* was disabled. What happened from this point is not clear. We know that as the Admiral stopped he signalled to *Tiger, Princess Royal,* and *New Zealand* to close on and attack the enemy. The *Blücher* had been allotted to the *Indomitable* some twenty minutes before. Whether the squadron stopped when the *Lion* stopped, or whether it proceeded in an unsuccessful attempt to carry out the Admiral's orders, is not said. The admirality's version of what followed is that the enemy were able to continue their retreat into a region where mines and submarines prevented pursuit. In a preliminary dispatch Sir David Beatty had said the *presence of submarines* necessitated the action being broken off. German accounts placed the disablement of the *Lion* at a point seventy miles from Heligoland. All we know for certain is that on the *Lion* stopping the command of the squadron passed to the Rear-Admiral in *New Zealand.* All that is authentically known of the conclusion of this action is as follows:

The enemy's ships must, of course, have been lost to Sir David Beatty's sight within very few minutes of *Lion* stopping. Sir David Beatty called the destroyer *Attack* alongside and transferred his flag to her soon after half-past eleven. He then proceeded at full speed in pursuit of his squadron. It is clear at 11:45 not only the enemy but all Sir David's ships had been out of sight. *Blücher,* with *Indomitable* attacking her, was out of sight also. After a chase of between forty and fifty minutes he found the squadron retiring northwards. He then hoisted his flag in *Princess Royal* and learned from her Captain that *Blücher* had been sunk and that the enemy cruisers,

considerably damaged, had continued their course eastward. The circumstances in which the enemy were allowed to retreat have been much discussed, and there is nothing to add to the considerations that are already so well known.—*Land and Water.*

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AUSTRIAN FIELD INSTRUCTIONS

H. Schmid's "Tactical Handbook" (*Taktisches Handbuch*) 15th Edition, Vienna, for the year 1916 has just appeared on the market and contains, in its first pages, a succinct compilation of the more important lessons of the present war. While, perhaps, somewhat premature, these lessons are based on the actual experiences of the Austrians against the Russians, Servians, and Italians and are for this reason instructive. The following is a translation of the compilation.

Combat

Insigna of rank to be covered in combat. Leaders not to differ conspicuously from subordinates in uniforms. Orders clear and precise; clear statement of mission. Strive to partially envelope the hostile supporting points by threats from flank and rear, even with inferior forces of infantry and cavalry. Be sparing of ammunition. Take the greatest care against surprises in villages. Optical signal men to be well covered from hostile view. Enemy has sought to deceive with white flags and cloths; therefore, do not cease firing until weapons have been thrown away. Enemy uses our uniform—be careful. Apply the regulations for the service of security on the march and at rest.

INFANTRY

Reconnaissance

At first, by patrols; when the enemy is in position, then by *very thin skirmish lines* about two platoons per battalion with ten paces interval between skirmishers. Patrols to reconnoiter terrain, roads, and bridges as well as enemy and to send back information at once. Movements in hostile artillery fire: very *thin lines* with 500 to 600 paces distant.

Attack

After thorough reconnaissance, advance in *very* loose skirmish lines. Flanking positions in front, or to one side, of the frontal position, as well as weaker advanced lines must be thoroughly reconnoitered and taken from the flank if possible. Detachments in front, to *intrench at once.* A slow and well considered advance, proper fire discipline, slow firing—not too hasty in fire surprises. Reserves: Bring forward by collecting them to the front in *small groups and thin lines. Continuous security of the flanks*—also after occupation of the hostile position. Keep up connection of units by telephone as far as possible; keep oriented as to the situation of adjoining units. Frequent reports of the situation. Trustworthy orderlies.

Defense

Sunken trenches to the depth of a man, covered by the minimum parapet, screened, and on the slope toward the enemy. Artillery support. Dummy works. *Every man an intrenching tool*—long handled preferable. Officers and non-commissioned officers must be instructed with the handling of explosives and means of ignition. Combat in woods: observation of the

trees since hostile riflemen or machine guns are frequently installed in them; security at audible distances; order; maintenance of *objective* and greatest *silence*. High shrapnel fire clears out tall timber at the edge of the woods. Repulsing cavalry attacks: open fire as early as 800 paces. Retreat arranged in small units alongside one another—security of flanks.

MACHINE GUN DETACHMENTS

Rapid occupation of the position; intrench; dummy works. *Digging tools for each man*—always provide head and side cover. *Sticking it out is better than a meaningless withdrawal.* In case of final retreat, one gun at a time. Choice of fire position: keep away from objects and corners of woods; always avoid setting up in small clumps of woods; guns at least 50 paces apart and not the same distance to the front. Fire and ammunition echelon: the latter to be in open ground at least 1000 paces *to the rear.* Support: at least one infantry platoon which also furnishes connection to the rear echelons. Tactical employment: in attack, first of all, on a *flank* with cover, single guns on a broad front; advance successively using the ground skillfully—best results at 1000 paces, a closer advance brings too many casualties. In consequence of their accuracy of fire and effectiveness, it becomes in a measure the duty of machine guns to supervise the field of combat in front and on the flanks. Where there is no field of fire and, finally, at night, machine guns with the reserve.

CAVALRY

Accustom the horses to camp in the open and to field forage. Require fewer rapid gaits as compared with long quiet movements from place to place. For the rider, special *training* in the use of *fire arms* is essential—horseman must be drilled to fight on foot and, therefore, to intrench rapidly. *Charges are of no importance.* Be careful in pursuit of hostile horsemen on account of fire surprises.

ARTILLERY

Careful preparation and skillful use of ground. When possible, concentric and flanking fire. Field howitzers very useful against covers in spite of lesser ranges; therefore, employ the terrain for this purpose and strive for flanking fire. Scanty observation and overhasty opening of fire have often resulted in our troops firing upon each other which must be avoided under all circumstances. Shrapnel fire often too high a bursting point; consequently, diminished effect. Target reconnaissance and fire observation especially important; therefore, send own reconnoiters suitably far to the front—avoid observing stations too far to rear as they are generally worthless. Church towers draw artillery fire. Hostile batteries are generally concealed—can be discovered only by creeping patrols and aviators. A covered artillery position for yourself is the rule, but not too near to the cover; guns with increased distances, resulting in batteries being frequently employed singly in order better to utilize the ground. A common, strict fire control in the unit prevents wastage of ammunition. Intrench, even in covered positions, and a free use of screens and dummy works. The Russian heavy army artillery (10.6-cm. guns) is effective to about 10 km. and the 7.5-cm. field guns to about 6 km.; therefore, infantry must be prepared for a surprise fire at those distances. Consequently, reconnoitering and security patrols to the front and side.

COMBAT IN STONY GROUND

Especially difficult because intrenching with the spade is impossible and the hostile fire effect, especially of the heavy artillery, is very much increased by the splinters. Covers are set up in first order with sand bags and only where these are not obtainable will stone piles be erected; if the latter are suitably strong, they will protect against infantry fire at least. Installation of traverses highly important. When possible and explosives are available, *dig down*. Quarrying tools and explosives play a great rôle. Utilize corrugated iron. Cellars excavated in slopes at least three meters under the firm ground protect against artillery fire. Make a free use of mine throwers.

RECENT GERMAN NAVAL CONSTRUCTION

By M. K. Barnett

For some months past a shroud of mystery has enveloped the warships under construction in German yards.

The situation at the commencement of the war was as follows:

A class of four battleships of the "König" type was nearing completion, her sister ships being the *Grosse Kurfürst*, *Markgraf*, and *Kronprinz*. These were designed for a displacement of 25,575 tons, with engines of 34,000 horsepower. They aimed at a minimum speed of 21.5 knots, while ten 12-inch guns were chosen as a main armament.

In addition to these, there were three battle-cruisers in an advanced stage of construction, the *Derfflinger*, *Lützow*, and *Ersatz Hertha*. The design of these being: displacement, 26,600 tons; armament, eight 12-inch guns; and speed, 27 knots. The only other capital ship approaching completion was the *Salamis*, then building for Greece.

A certain German naval officer, interned in Holland, stated in June last that the *Kronprinz* and *Lützow* (the former the last vessel of the "König" type of battleship, and the latter a battle-cruiser of the "Derfflinger" class) had been rearmed and completed with 15-inch guns instead of the usual German 12-inch weapon.

The assertion that the *Kronprinz* and *Lützow* were completed in June last is probably correct, but they were far too near completion for rearming at the time when the *Queen Elizabeth* started bombardment in the Dardanelles. Yet the officer definitely stated that it was the news of the success of the British 15-inch gun in this work that caused the German shipbuilders to rearm these two ships.

Further, the officer spoke of "four more dreadnoughts" to be completed by the end of 1915. Now everyone will grant that this year will see all the "Königs" in commission, but certainly not four additional battleships.

In 1913 Germany laid down two "15-inch gun" ships of the "Ersatz Wörth" type, and another during the year following. By all possible acceleration they might just be finished six months under the normal time. This would mean two only being completed in 1915 and one in the following year.

In view of these erroneous statements by the German officer, one feels disinclined to accept his other assertions.

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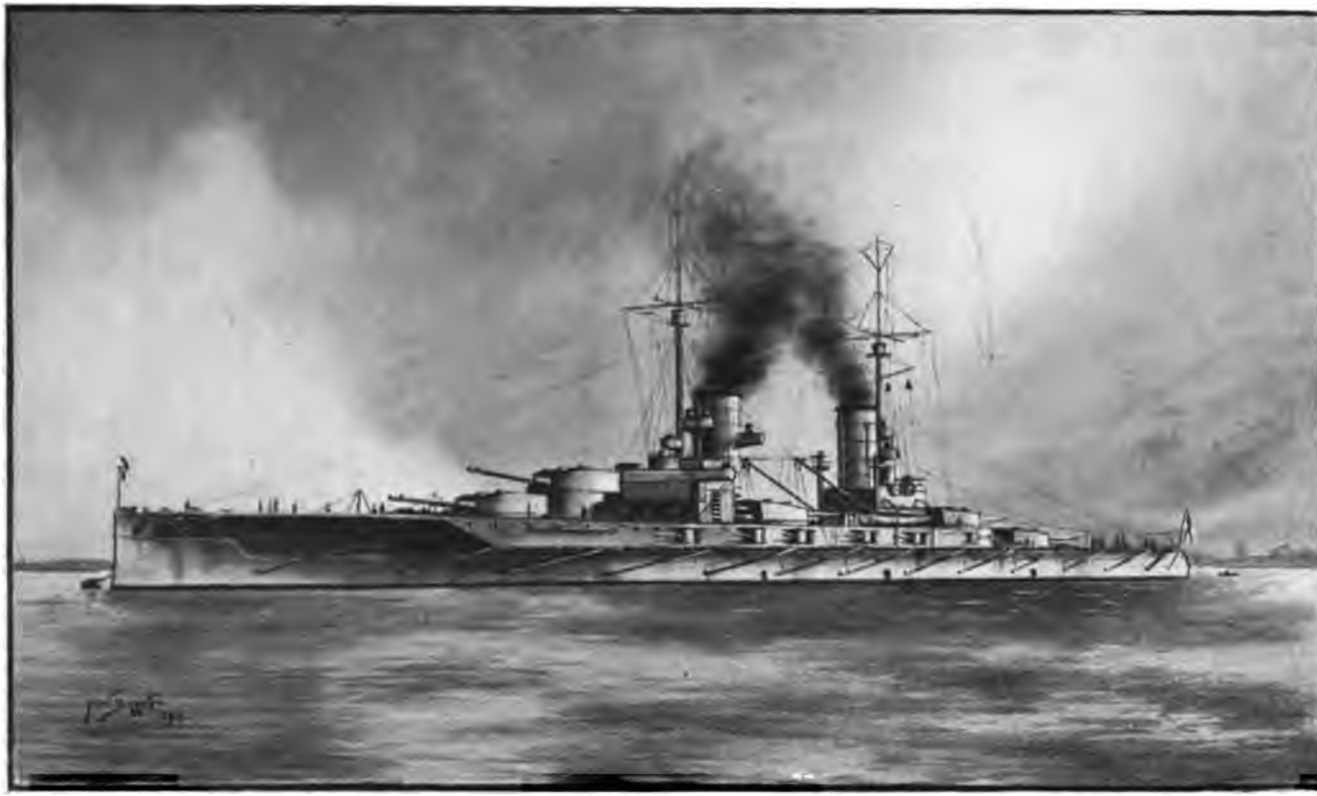
Scientific American. GERMAN BATTLE-CRUISER "LUETZOW" 1790

DISPLACEMENT, 26,600 TONS; LENGTH, 689 FEET; SPEED, 27 KNOTS. ARMAMENT: EIGHT 12-INCH, TWELVE 6-INCH, TWELVE 3.4-INCH GUNS



Scientific American. GERMAN DREADNOUGHT "KRONPRINZ" 1789

DISPLACEMENT, 25,575 TONS; LENGTH, 585 FEET; SPEED, 21.5 KNOTS. ARMAMENT: TEN 12-INCH, FOURTEEN 6-INCH GUNS

Scientific American. GERMAN BATTLE-CRUISER "LUETZOW" 1790

DISPLACEMENT, 26,600 TONS; LENGTH, 689 FEET; SPEED, 27 KNOTS. ARMAMENT: EIGHT 12-INCH, TWELVE 6-INCH, TWELVE 3.4-INCH GUNS

GERMAN DREADNOUGHT "SALAMIS"

DISPLACEMENT, 19,500 TONS; LENGTH, 571 FEET; SPEED, 23 KNOTS. ARMAMENT: EIGHT 14-INCH, TWELVE 6-INCH GUNS

He affirmed that besides the four battleships (of which examination reveals two only) "a number" of battle-cruisers would be added to the German fleet before 1916. As previously stated, the *Lützow* may well be in commission (but not with 15-inch guns). The next battle-cruiser in order of completeness is the *Ersatz Wörth* which was only launched in September last, and it is thus obviously impossible that she should hoist her pennant for some time to come.

The only way in which he could show the least evidence for his "number" of battle-cruisers, is by including the *Salamis*, which is another story. This ship was laid down for Greece at the German Vulcan Yard in 1913, and was to be armed with eight 14-inch guns by the Bethlehem Steel Company. Had the American firm delivered the guns and mountings before the commencement of the war, which is questionable, the ship would no doubt be completed. But if not, there would be difficulty in arming her because the German 14-inch guns are fortress guns and have not been mounted in warships hitherto.

Summing up, therefore, this naval officer's astounding assertions, we find that the *Markgraf* and *Lützow* could not have been rearmed at the late stage he mentioned; that the "four" battleships to be added to the "Königs" by 1916 cannot be more than two; and that the "number" of battle-cruisers is reduced to one "doubtful" viz., the *Salamis*.

As regards submarines: No one outside the circle of German naval constructors can make any definite statement; but, considering that Germany has devoted enormous energies to this arm, it is quite within the range of probability that since the beginning of the war they may have added sixty to the large number they already had in hand.

Reverting to the "König" type of battleship: as will be seen in the illustration, there is no special novelty in the design, being particularly like the previous "Kaiser" class, except that Germany has adopted the super-imposed turret system fore *and* aft, abandoning the *en echelon* system. It seems strange that the main armament of these ships—laid down in 1913—should be identical with that of the original British *Dreadnought* laid down eight years before, viz., ten 12-inch guns. Such is the German faith in the Krupp gun. The armor, however, is extensive and heavy. Not only has the main belt a maximum thickness of 14 inches, but the funnels are encased in 6-inch armor to a height of 20 feet above the main deck; and a 3-inch underwater skin is fitted for 350 feet amidships. Besides this the designers have provided two conning towers, four special armored fire control stations, and one torpedo control tower.

The "Derfflinger" type of battle-cruiser is a natural development of the previous *Seydlitz*. As in the "Königs" the *en echelon* system has been abandoned in favor of two pairs of super-imposed turrets, and these ships mount two guns less than the former type to increase the caliber from 11 inches to 12 inches. Again we notice that these battle-cruisers, laid down in 1913 and displacing 26,600 tons, have the same armament as the British "Indomitables" (the first ships of the true battle-cruiser type) laid down six years earlier and only displacing 17,250 tons. Perhaps the most noticeable innovation, however, is the battery of twelve 3.4-inch guns mounted high up in the superstructure amidships, a position which would give greater chance of beating off an attack by hostile submarines. Also, as defense against aircraft, an unknown number of anti-aerial guns are being mounted, and a 4-inch protective upper deck is provided.

The *Salamis* is a vessel of 19,500 tons and mounts eight 14-inch guns in four turrets: two forward and two aft, the innermost turrets super-imposed. Designed for only 23 knots, she does not mark any particular advance in warship design, being, rather, an effort to combine the greatest defensive and offensive qualities with the least cost.

In conclusion we find, therefore, that beyond a considerable increase in submarine output, Germany could not have increased her fleet in any extraordinary manner; neither does she appear to have introduced any new phase or notable advance in the ships she has constructed since the commencement of the war.—*Scientific American*.

AMERICA'S FIRST THIRTY-FIVE KNOT BATTLE-CRUISER*

Common sense teaches everyone that speed, range, striking power, and adequate armor protection, are essential in a fighting vessel and the ship in which these are combined to a pre-eminent degree most fully meets the ideal. But it is no easy matter to unite all these attributes in a single craft of a given tonnage. If a battleship is excessively armored, weight must be saved elsewhere—in guns, engines, etc. And so it happens that every fighting ship is more or less a compromise effected by the advocate of speed with the advocate of heavy guns and thick armor.

Although the developments in battleship construction have been exceedingly rapid, the greatest impetus was given about ten years ago when Great Britain came to the fore with the Dreadnought, a ship which mounted only big guns, namely ten twelve-inch rifles. She was fast too, for her speed was twenty-one and one-half knots, something unprecedented in battleships.

Soon the superdreadnought appeared, a vessel still faster, mounting still bigger guns, and still more heavily armored. Then came the battle-cruiser, a formidable craft with a speed of twenty-eight knots—a type also first introduced by Great Britain.

These battle-cruisers—vessels which mount somewhat fewer heavy guns than the superdreadnought, but of the same caliber, and which have somewhat lighter armor and the greatest speed that can be given to a warship are at last to be introduced in our own navy. If we were to engage now in a naval war with a foreign power, we would be hopelessly at a disadvantage, not only because of the fewness of our superdreadnoughts, but because we utterly lack battle-cruisers.

While no official announcement has been made of the principal features of these new ships, the *Popular Science Monthly* is in a position to present details which may be accepted as accurate.

Profiting by the lessons taught by the engagements fought off the Falkland Islands and in the North Sea, this new battle-cruiser of ours is to have a speed somewhere between thirty-two and thirty-five knots. Obviously engines of enormous power are required to attain that speed, and so we may expect that one hundred thousand horsepower must be generated. Ever additional knot means an inordinate increase in engine capacity.

Our unbuilt and unnamed battle-cruiser will have eight fourteen-inch guns and twenty five-inch guns. At first blush it would seem as if the

* See frontispiece.

Queen Elizabeth's fifteen-inch guns must carry the day if these two ships were ever opposed. But our ordnance officers have made the statement that the new fourteen-inch guns which they have developed are the superior of the fifteen-inch guns at present used in the British navy—or statements to that effect.

The armor protection of the new United States battle-cruiser is to be twelve inches amidships and four inches at the ends. The *Queen Elizabeth* has thirteen and one-half inches of steel on the waterline, ten inches above that and a top layer of eight and one-quarter inches. It is here probably that we had to make our sacrifice in order to gain the engine power and, therefore, speed. But if speed will enable our ship to pick out her own position and our guns have the greater range, the loss in armor protection is more than compensated for.

The *Lion* and *Tiger* are battle-cruisers in the true sense of the word. Our ship will easily outdistance them. In tonnage there is not much to choose, for they displace thirty thousand tons as against the thirty-one thousand tons of our vessel. In armament we will be far superior. The *Lion* and the *Tiger* each mount eight fourteen-inch guns which are probably inferior in range to the guns of equivalent caliber on the proposed American ship. The *Tiger* has twelve six-inch guns and the *Lion* sixteen four-inch guns; but weapons of such small character play no part in a long range engagement and are serviceable chiefly for the repulsion of torpedoboats.

—*Popular Science Monthly.*

TWELVE-CYLINDER ENGINES*

J. C. VINCENT†

While getting the data together for this paper, I came across a copy of a letter addressed by me to the president of my company, just after I had completed exhaustive experimental work with various types of engines, in which I finally recommended the adoption of the twelve-cylinder type in our cars. In this recommendation I went into the subject very thoroughly, and I know of no better way to explain why we adopted the type of motor under discussion than that followed in this report.

We had reached the point of putting into our line a model 28 which would stand in relation to the 38 car as the 38 stood to the 48. The engineering department had turned over to the factory complete drawings of this 28 car, as well as a sample. But after a conference we decided not to go ahead, and called back all information from the factory, on account of various doubts whether further delay would not enable us to deliver a better result to our patrons. Therefore, again, for a number of months, we were kept busy in the engineering department redesigning and testing this car. This experimental work yielded an improved 28 car. In addition to the chassis improvements that were worked out, we produced a high-efficiency six-cylinder engine. It developed practically the same horsepower as our 3-38, although it had about 100 cubic inches less displacement.

During the development of this 28 engine and after we had succeeded in getting the increase in horsepower, we began to plan the same construc-

* A paper presented at the Detroit meeting of the Society of Automobile Engineers.

† Vice-President of Engineering, Packard Motor Car Company.

tion for our next lot of 38 cars. The revised 38 engine developed more horsepower than the best 48 we had ever built. While we were carrying on this research work I became convinced that the small-bore high-speed type was going to be the final answer in this country, as it had been in Europe, but that on account of our road conditions and the demand for maximum range of ability, it would be necessary for us to use more cylinders than has been common practice abroad.

Steady improvement in the design and construction of motor cars for many years has made the user more and more exacting in his demands, but from the first there have been three things that every motorist has asked for—more range of ability, greater smoothness, and less noise. The average motorist desires more range of ability because he likes to accelerate rapidly and ascend steep grades without handling the gear-shift lever, and above all perhaps without the noise inseparable from indirect gearing. Noise and vibration are distressing to the nerves when long endured. To find the way to combine properly the three qualities has taxed the ingenuity and skill of engineers all over the world.

For a long time the six-cylinder engine seemed to fill the bill, but as we have refined every detail of the car step by step, it has been brought home gradually that the comparatively smooth result we have been getting from six-cylinder engines is not the final answer. It is easy to see that the force of an explosion must be in proportion to the volume of gas exploded, so that the impulse given to the piston, as well as the corresponding recoil on the cylinder, is greater as we make the cylinder larger. With a six-cylinder engine running slowly, as when pulling through traffic on high gear, it is possible to feel each effort as the charge is fired in one cylinder after another; when the accelerator pedal is depressed, the push of each successive explosion can be felt by every occupant of the car. As the speed rises and the explosions follow one another faster this sense of effort disappears, but in most sixes we reach a point where distinct vibration arises. This comes from a different cause, namely, the weight of the pistons, and is more difficult to overcome as we make the engine larger. A six-cylinder engine is theoretically in absolutely perfect balance, because the vibratory forces due to the rise and fall of one piston are neutralized by equal and opposite forces due to another. The pistons form a system of bodies and the forces existing in each individually have no effect on the whole lot considered together on account of the cancelling of one force against another. It is possible to cancel out forces in this way only if the parts acting are tied together strongly. Suppose we have a piece of short-heavy shaft, supported in bearings, with a crank-handle at each end. Two men of equal strength can pull on the crank-handles and against each other without either moving, but if the shaft is long and therefore more easily twisted, they will each move back as they pull. If they pull always together, but in a series of jerks instead of steadily, they will rock to and fro against the twist of the shaft. The pistons in an engine act similarly. Each pushes and pulls on the rotating crank-shaft, and the pulls and pushes of all the pistons amount to zero just as long as the crank remains absolutely stiff and true. Let there be ever so slight a twist in the shaft and the forces will no longer cancel without a movement of the whole piston mass—and if the center of gravity of the piston mass moves by even a minute fraction of an inch, we have at once vibration that is unpleasant. This has, of course, nothing to do with the explosion force, but is solely a matter of the inertia

of the pistons as weights being pumped to and fro by a crank. Doubling the area of a piston more than doubles its weight and, conversely, if we halve its area, we more than halve the weight. The stresses due to piston reciprocation follow the weights, so a three-inch piston has much less than half the capacity for vibration-making that a four-inch one has.

Let us now come back to the explosion again. Imagine a six-cylinder crankshaft held rigidly at the flywheel and supported in its bearings. If we put enough pressure on one of the crankpins, we can twist the shaft a little. The bearings prevent it from bending but not from twisting. With a big piston the explosive force on the large area of its head is great and may even be great enough to actually twist the crankshaft a little, assuming the driving resistance of the car is enough to hold the flywheel rigid, so to speak, against the effort of the explosion in the front cylinder. This effect does actually occur in big sixes unless the crankshaft is large in diameter, which means weight. Also, to eliminate all spring in a shaft so that it can cancel the forces due to the reciprocation of the piston, apart from the explosion, necessitates stiffness and weight in the crankshaft as well as a heavy crankcase, so that the crankshaft bearings can withstand rigidly any tendency of the shaft to whip or bend. These may sound like small things, but they are large in effect; many an engineer has had sleepless nights seeking the cause for some irritating vibration in his six. In almost all cases the remedy is the same—more weight in the crankshaft and crankcase.

There is another and a better method, the employment of less piston weight and smaller explosions. We want not only the present but a greater range of ability. Therefore we must have more pistons. As soon as we try the effect of many light pistons of small size, and many explosions of small intensity, we find we obtain other advantages. For instance, the flywheel is needed to carry the crank on while there is no explosion to drive the car; even in a six there is a considerable variation of effort between one explosion and the next. Using many small pistons to get an engine of the necessary power, we save piston, crankcase, crankshaft and flywheel weight. Moreover, we get more power from an engine of the same displacement than is possible from a six of a corresponding standard of engineering. This is because the light pistons and connecting-rods allow the engine to have a greater range of speed. The smaller bore of the cylinders permits the use of a higher compression; and the higher the compression the more efficient is the burning of the gas at all speeds.

At this point come some very natural questions. How far can this principle be carried? How far does it pay to go in number of cylinders? How small can we make them and get all the advantages? What is the best arrangement? It seems obvious that the V type is the best arrangement, as it allows the use of a short stiff crankshaft, short light stiff motor, and in turn, of course, the shortest possible wheelbase.

The most successful European engines have cylinders of between 3-inch and 3¾-inch bore. For smooth running the very long-stroke engine has proved inconvenient; a 5-inch or 6-inch stroke is what high-class European motor car builders have found to be best, all things considered.

Let us consider the possibilities of the eight-cylinder V engine, as this has received considerable attention and seems to be the next logical step after the six. For the purpose of comparison, suppose we desire an engine of about the same displacement as our 3-38 six, which is 4-inch bore by 5½-inch stroke (414.7 cu. ins.). It would be possible to design an eight-

cylinder V engine of practically this same displacement within the above-mentioned desirable bore and stroke limits. An engine of 3-7/16 inch bore and 5¾-inch stroke will contain just over 53 cu. ins. per cylinder, or a total of about 424 cu. ins. Such an engine of proper design and workmanship would have certain advantages and disadvantages when compared with a six. So far as the character of the *torque* is concerned, the eight has advantage over the six by reason of more frequent impulses of lesser intensity. So far as *weight* is concerned, it would have some advantage, particularly in the crankcase, crankshaft, and flywheel. The shorter crankshaft can be made smaller, because it is shorter and the light pistons and small impulses do not have the same tendency to twist it. So far as *smoothness* is concerned, the eight is better than the six at moderate speeds because of more even torque, and the inherent vibrations due to unbalanced inertia forces are not a factor. At the higher speeds, the advantage is with the six, as the unbalanced inertia forces become an important factor, and in spite of the lighter pistons and shorter crankshaft, the vibration is a great deal more pronounced in the eight than in the six. This is an undesirable feature, because one of the reasons for using more cylinders is to increase the range of engine ability, and at the same time its smoothness. So far as *accessibility* is concerned, the eight is at a disadvantage when compared with the six. Any of the equipment mounted below the frame is, of course, exposed to mud and water, and in addition to being inaccessible, is apt to be damaged. The larger part of these units is usually mounted between the cylinder blocks, in what might be called the "valve alley," with the result that the valves are rendered inaccessible. The required angle of the cylinders also makes it difficult to design a properly substantial steering gear and still render assembling practicable. In the best workouts I have seen, the assembling and disassembling of the steering gear is difficult and in most cases it is necessary to remove the body and partially the engine to get the steering gear out. So far as the *turning radius* is concerned, the eight is at a disadvantage when compared with the six, as the frame must be made wider than necessary for the six in order to get the steering gear in at all. An inch in width on each side of the frame increases the length of the turning radius a great deal more than three or four inches added to the wheelbase. In other words, the amount that the wheelbase can be shortened with an eight, will not make up, so far as turning radius is concerned, for the extra width required at the front end of the frame. All things considered, it is obvious that along with the acknowledged advantages obtained from the eight, re-appear the characteristics of the four that the six was designed to overcome.

The six is an absolute theoretical and practical balance if properly designed with a crankshaft strong enough to take care of the inertia forces. The only disadvantages of a six are that in order to get a reasonable size the crankshaft must be long and the inertia forces are large owing to the necessarily large pistons. Since a six is in perfect balance, however, there is no reason we cannot combine with it another six, V-type, and still have an engine in absolute theoretical and practical balance. In designing this twelve-cylinder engine, however, it is necessary to set the cylinders at an included angle of 60° instead of 90°, as there are six impulses per crankshaft revolution instead of four.

Let us see how this type of motor compares with the six and the eight. The character of the *torque* of the twelve is 50 per cent better than that of

the eight and 100 per cent better than that of the six. Six impulses per crankshaft revolution blend together so closely as to make it impossible to distinguish any pause between impulses, even at low engine speeds pulling through traffic on grades. So far as *weight* is concerned, the twelve is just about equal with the eight, but lighter than the six. The twelve is slightly longer than the eight, but, owing to its smaller bore and stroke and lesser angle, makes up in narrowness. Owing to the perfect balance of the six-cylinder construction, the twelve is absolutely *smooth* at all speeds. So far as *accessibility* is concerned, the twelve is far superior to the eight. The 60° angle included between cylinders allows us to build a 424 cu. in. motor 21½ inches wide over all, as compared with 28-9/16 inches in the case of the eight. This permits placing the generator, waterpump and starting motor in the usual place alongside the crankcase and between it and the frame without widening our previous standard frame. It also permits the easy assembling and disassembling of a properly designed steering gear. It leaves only the carbureter to be placed between the cylinders. By placing it well above the motor the valve alley is left entirely open and all valves are readily accessible. So far as *turning* is concerned, the twelve is far superior to the eight and slightly better than the six, as it is mountable in the same width frame as the six and makes possible a substantial reduction of wheelbase.

Coming back to the three important results desired, ability, smoothness and quietness, I believe that every well-informed engineer will agree that the results obtained from a car equipped with one of the twelve-cylinder V engines gives an entirely new measure of these qualities. The unusually large range of smooth powerful action is valuable primarily on account of the ability to remain in high gear at slow speed in traffic, to get away quickly, sweep up grades and out of critical situations without the annoyance of changing gears or the danger of stalling the engine. The characteristics that accomplish these desirable results also permit sustained high speed without disagreeable vibration.

I believe that the perfect balance of the twelve, with light, accurately machined reciprocating and rotating parts, and the higher compression that the small cylinder bore makes practicable and the improved carburetion due to uniform suction, result in noticeable gasoline and oil economy. The uniform torque developed by the engine is an important factor in tire economy.

In building the experimental twelve-cylinder engine, I made it 3-inch bore by 5-inch stroke, or of approximately the same displacement as our 3-38 six, with the idea that if it proved out satisfactorily, it would be the right size for the new 38 car and that we would build a smaller one for the 28 car. When this engine was completed, however, and I had become thoroughly acquanited with its characteristics, I found that it had such a range of ability and was so compact in form as to make it necessary to build another smaller engine for the 28 car. I could put the new engine into the 28 chassis without lengthening the wheelbase or increasing the length of the hood.

I believe that the unbalanced forces due to inerita are understood thoroughly by engineers, but have thought best to discuss them briefly in order to make this paper more complete. Fig. 1 shows a partial cross-section of an eight-cylinder engine of 3-7/16-inch bore and 5¼-inch stroke; total piston displacement 424 cu. in. This drawing was made primarily to show the rotating and reciprocating parts. Assuming that the center of gravity

of each piston is located in the piston pin, in order to locate the center of gravity of all four pistons in the right-hand block when they are at dead center, as shown in the drawing, it is necessary only to bisect the distance between the piston-pins to obtain the center of gravity of all four pistons, as indicated at *A*. With the crankshaft in this position, it is easy to locate the center of gravity in the left-hand block, as the pistons in it are all lined up. In other words, the center of gravity is at the piston-pin, as indicated at *B*. The drawing shows an arc struck from the center of the crankshaft and passing through the center of gravity of the pistons in the right-hand block at *A*. It does not pass through the center of gravity in the left-hand block, but considerably above it. This result is due to the angularity of the connecting-rods and can be increased or decreased according to the

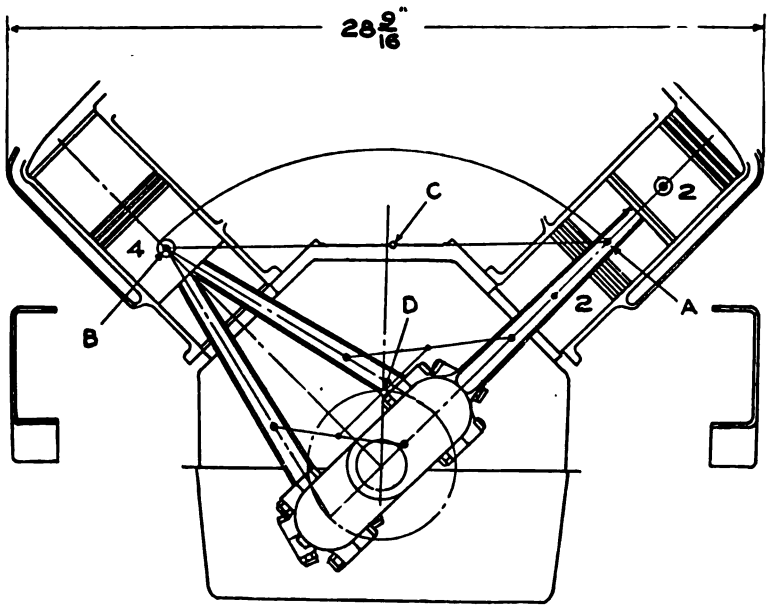


FIG. 1. 1792

PARTIAL CROSS-SECTION OF EIGHT-CYLINDER ENGINE

ratio of connecting-rod length to stroke. With any permissible length of connecting-rod this error cannot be cut below approximately ⅜-inch and is apt to run considerably more. A rough way to calculate the magnitude of this unbalance is to consider that the engine is equipped with one additional piston, whose weight is equal to the combined weight of all the pistons, and that this piston is reciprocated at twice the crankshaft speed through a stroke equal to the movement of the center of gravity of the pistons. In a single four engine this movement of the center of gravity causes a vertical vibration, but in an eight-cylinder the movement of the center of gravity in one four-cylinder engine cancels the movement in the other four-cylinder engine, so far as the vertical component of these forces are concerned, but the two are added so far as the horizontal component is concerned.

Fig. 1 shows a line drawn between the two centers of gravity, and this line is bisected at *C* to show the horizontal movement of the combined center

of gravity to the right of the verical center line with the crankshaft in the position shown. Revolving the crankshaft 90° will move this combined center of gravity an equal amount to the left of the vertical center line. The movement of this combined center of gravity causes horizontal vibrations in an eight-cylinder engine.

Fig. 2 shows a partial cross-section of a twelve-cylinder engine of 3-inch bore and 5-inch stroke; total piston displacement 424 cu. ins., the same displacement as that of the eight-cylinder engine shown in Fig. 1. I have located the centers of gravity of the pistons in each block in this drawing in the same manner as described in connection with Fig. 1, but the arc struck from the center line of the crankshaft passes through the center of gravity in both blocks, and also the combined center of gravity of all pistons

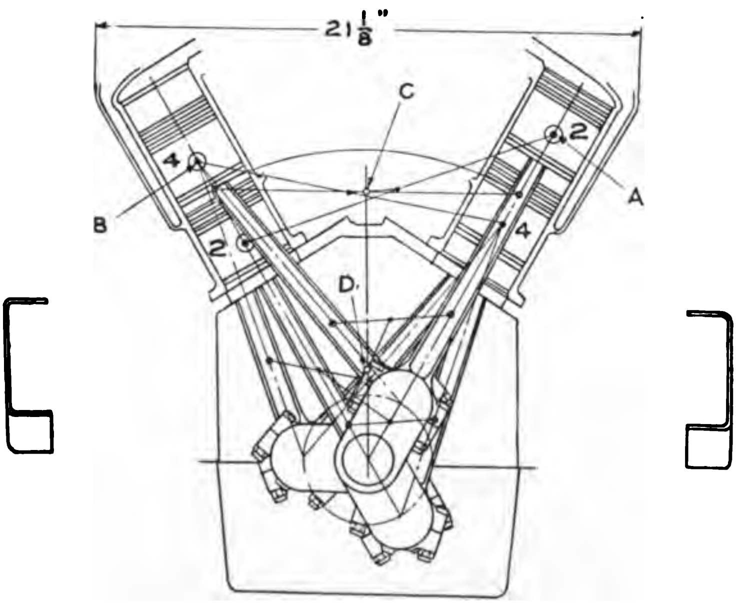


FIG. 2.
PARTIAL CROSS-SECTION OF TWELVE-CYLINDER ENGINE

falls exactly on the vertical center line instead of to one side, as in the case of the eight-cylinder engine. The reference letters *A*, *B*, and *C* indicate the same points in this drawing as in Fig. 1. This drawing shows, of course, the relation of the parts at only one position of the crankshaft, but by plotting the parts at every degree of movement of the crankshaft it will be found that the center of gravity does not move from a fixed point. I have had the centers of gravity of all the connecting-rods plotted for both engines. In the case of the eight, this point moves off the center line as indicated at *D* in Fig. 1, while it remains absolutely fixed on the center line in the twelve, as indicated at *D* in Fig. 2.

Figs. 1 and 2 are made to the same scale. A section of a desirable width of frame is shown in each drawing, in order to give an idea of the general layout of the two engines and of the possibilities of installing equipment. Fig. 1 shows the difficulty of locating accessories in the usual place alongside

the crankcase, and between it and the frame, and also that the steering gear must be located to the rear of the cylinder blocks. Fig. 2 shows the ease with which the accessories can be located alongside the crankcase, and between it and the frame, and also the additional room for the accommodation of the steering gear. This makes it possible to use a triangular drive and single chain for driving the camshaft, generator, and water-pump.

The water-pump, located just back of the generator, is really no more complicated than the ordinary six-cylinder water-pump, and just as accessible. It has two impellers so placed that the end-thrust is balanced, one

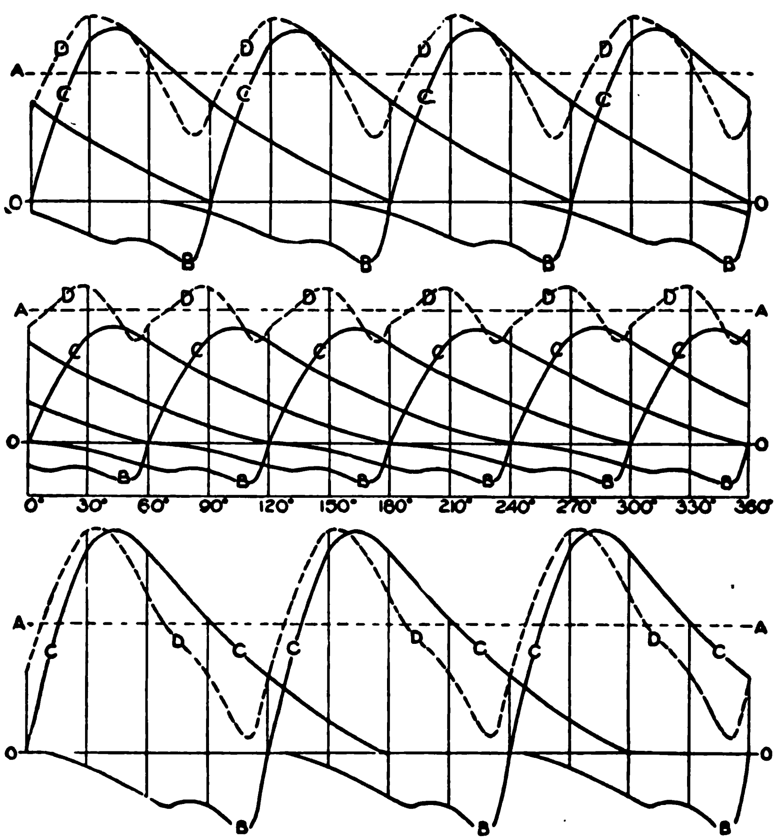


FIG. 3.
TORQUE CHARACTERISTICS OF EIGHT, TWELVE, AND SIX-CYLINDER ENGINES

delivering directly to each of the two cylinder blocks. With this pump it is only necessary to have a single stuffing-box, which is accessible for repacking.

The starting motor is directly back of the water-pump, and cranks the engine through compound gearing acting on the flywheel, according to the construction standard on our six-cylinder motors for some time past.

The air-pump and oil-pump are driven by small spiral gears at the rear end of the camshaft. The ignition timer unit is driven by a pair of small spiral gears at the front end of the camshaft. This makes a simple, light,

and quiet arrangement, which is cheaper to manufacture than that used in the majority of four or six-cylinder engines. It is unnecessary to place equipment in the V between the cylinder blocks, with the exception of the carbureter, which is located high up, thus leaving every valve accessible for adjustment.

Considering this twelve-cylinder engine as a complete unit, I believe it is just as accessible as a well-designed single four or six-cylinder engine.

Figs. 1 and 2 make it clear that the hood, and therefore the frame, for an eight-cylinder engine must be considerably wider than for a twelve of the same piston displacement. The twelve is about 21¼ inches wide over the cylinder blocks, while the eight is 28-9/16 inches.

A six engine would, of course, go into the width of frame shown in Fig. 2, but an engine of this type of the same piston displacement would be some 5 inches longer than the twelve, necessitating a longer wheelbase and turning radius. Of the three types of engine the twelve is the best so far as turning radius is concerned.

I have weighed a great many engines and proved to my own satisfaction that of the three types, the six is the heaviest, and the twelve and eight about equal, granting that all three types are constructed according to corresponding standards of engineering.

In order to show the torque characteristics of the three types of engine I have had Fig. 3 prepared. The diagrams shown in this drawing cover 360° of crankshaft rotation. All three are made to the same scale and based on engines of 424 cu. ins. displacement. The center diagram represents the power impulses of a twelve, the upper diagram those of an eight, and the lower diagram those of a six. In each diagram the horizontal line *O-O* represents zero, the solid curve *B-B*, below the zero line, the negative crank effort due to compression, and the solid line curve *C-C* the crank effort due to the working strokes. The dotted line curve *D-D* represents the net crank effort, being plotted by taking the value of the positive crank effort curves and subtracting that of the negative crank effort curves. It shows clearly the relative work to be done by the flywheel in the three different types of engine. I have driven a car equipped with a twelve-cylinder engine at a speed as low as one mile per hour, representing an engine speed considerably less than 100 r.p.m.; and under these conditions there is no sense of separate impulses whatever, even when accelerating quickly from this speed.

Power Output

Without definite information to the contrary, it might be argued that with a given size engine, such as has been referred to in this paper, more power can be obtained with six cylinders than with twelve; as in the case of the argument advanced in the early days against the six in favor of the four. I have proved by actual experiment that the twelve develops not only greater maximum horsepower on account of its ability to run at high speed, but also more power at the lower engine speeds. We can make the compression higher without getting preignition because the smaller piston is easier to cool. Fig. 4 indicates the actual horsepower output of a Packard 3-38 six-cylinder engine of 415 cu.in. displacement and of a Packard twin six engine of 424 cu. in. displacement. Curve *F* shows the output of a new 3-38 six after being thoroughly tested, and curve *H* the output of the same engine after being run on the dynamometer long enough to limber it up and

put it in the condition that it would probably be in after 10,000 miles of service. The peak of this curve of the well-worked-in six runs up to about 67.5 h.p. at 1850 r.p.m.

Curve *E* represents the output of a twelve in the same condition as that of the six when it pulled curve *F*, and curve *G* the output of this same twelve after being thoroughly run in to correspond with the condition of the six when it pulled curve *H*. It will be noted that curve *G* runs up to 92.5 h.p. at 2600 and is still rising slightly. The peak of this curve is at 95 h.p. at 2800 and is maintained to 3000. It drops slowly to 3200 and then rapidly on account of the push-rods failing to follow the cams.

Curve *B* indicates the torque of the new six; *D* of the well-worked-in six. *A* represents the torque of the new twelve, and *C* of the well-worked-in twelve. These curves show the superior torque of the twelve at not

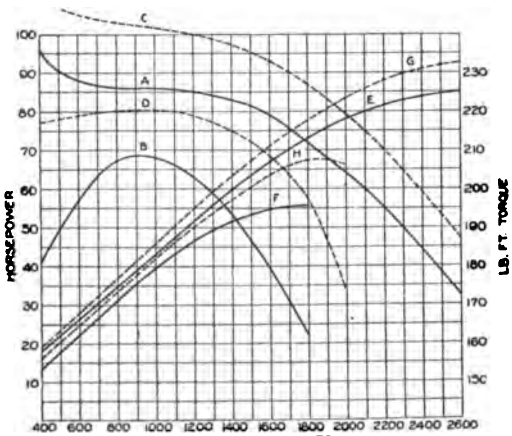


FIG. 4. 1795

F: H.P. OF NEW SIX. H: H.P. OF RUN-IN SIX. E: H.P. OF NEW TWELVE. G: H.P. OF RUN-IN TWELVE.
B: TORQUE OF NEW SIX. D: TORQUE OF RUN-IN SIX. A: TORQUE OF NEW TWELVE.
C: TORQUE OF RUN-IN TWELVE

only high but low speeds. That at low speeds is undoubtedly due to the more uniform application of power to the crankshaft, the higher compression possible and the better mixture resulting from uniform suction through the carbureter.

The difference in power output at the higher speeds is due partly to the increased compression and partly to the more effective valve area, but largely, I believe, to the lightness of the reciprocating parts and consequent reduction in friction. Both the six and the twelve have valves whose diameter in the clear equals half the bore, but as the six valves lift ⅜-inch and the twelve only 5/16-inch the effective opening is approximately 22 per cent greater in the twelve-cylinder engine. This is due to the fact that the piston area decreases as the square of the diameter, while the effective valve opening decreases directly with the diameter.

The power curve of the six was made from a 3-38, such as we used last year. The output of the high-efficiency six mentioned hereinbefore was considerably higher, running to approximately 75 h.p. at 2200. But to get this additional power, I had to not only lighten the reciprocating parts but increase the compression, thus obtaining more efficient combustion; in

other words, I had to increase the intensity of each explosion. This resulted in just what we were not looking for—a rougher engine than the 3-38. I believe that curve *H*, of the well-limbered-up 3-38, represents about the maximum output obtainable from a six without raising the compression to an objectionable point. On the other hand, the power indicated by curve *G* can be obtained from a twelve with a degree of smoothness far in advance of the result obtained from the six, even with its considerably smaller power output.

While the twelve-cylinder V engine has the ability to turn up to 3000 r.p.m., smoothly and safely, its high torque at low speed makes it possible to use a gear ratio that keeps the speed down to a point little above that of so-called slow-speed motors. As our 1-35 car, equipped with twelve-cylinder engine, is nearly 300 lbs. lighter than our 3-38, and has on an average 10 per cent more power up to 1500 r.p.m., we could have used our 3-38 gear ratio, 25 m.p.h. at 900 r.p.m., and secured excellent performance. The motor being capable of running at high speed without undue strain on the bearings, we decided to make the gear ratio slightly lower, 23.5 m.p.h. at 900 r.p.m., in order to give our customers a measure of ability satisfactory under all conditions. At 70 m.p.h. the motor turns only 2700 r.p.m.

Comparative Weight of Engine Parts

The following tables show the comparative weight (in pounds) of the rotating and reciprocating parts, and the resultant bearing pressures, of the six and twelve-cylinder engines, with corresponding data of the high-efficiency six.

Weight in Pounds

	3-38 Six	Special 3-38 Six	Twelve
Piston assembly complete with rings, piston-pin and set-screw	4.125	2.11	.814
Connecting-rod upper-end	1.38	.828	.625
Connecting-rod lower end	3.31	2.421	1.52

Forces (in pounds) *due to Gas Pressure and Inertia at 200 R.P.M.*

	3-38 Six	Special 3-38 Six	Twelve
Inertia of one piston assembly complete	2130	1140	492
Centrifugal forces of one connecting-rod, lower-end	1030	754	430
Centrifugal forces of one pair of connecting rod lower-ends	....	....	860
Crankpin bearing pressure per sq. in., due to inertia	768	433	379
Crankpin bearing pressure per sq. in., due to gas pressure	916	916	871

The lightening of the parts of the special six was accomplished by making the connecting-rods of alloy steel, they being machined all over, and using alloy pistons. The rotating and reciprocating parts were up to the standard of engineering of our twelve, which makes the comparison

interesting. On account of the lightness of the rotating and reciprocating parts of the twelve, its bearing pressures due to inertia at 2000 r.p.m. are far below those due to gas pressure on the piston. The speed of the motor would have to be raised far above 3000 r.p.m. to have the pressure due to inertia nearly equal the ordinary working bearing pressure due to gas pressure.

—*The Gas Engine.*

METHODS OF IGNITION

J. B. Dyer

Ignition, with reference to the internal combustion engine, is the igniting of the explosive charge within the engine cylinder at the proper time to deliver the force of the expanding gases to the piston, and is one of the essentials which has passed through wide changes and improvements in the course of development. Good ignition can be obtained by igniting the charge at the proper time with uniformity on varying speeds. It would seem at first thought to be a simple matter to construct a reliable machine to accomplish this, but the following description of the different improvements will show how much time and thought have been necessary to develop the present ignition system.

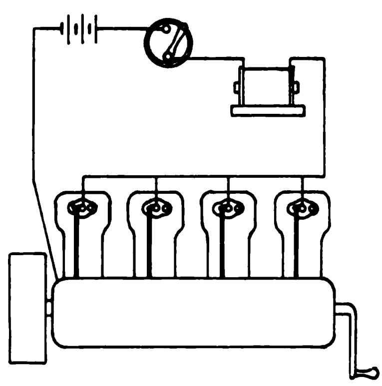


FIG. 1. MAKE AND BREAK TYPE OF ELECTRICAL IGNITION

The earlier forms of ignition apparatus were designed by the engine builder and, naturally, mechanical methods were used. The first successful ignition was the hot tube type. In starting the engine it is necessary first to heat the tube to a red heat, then inject a charge of gas into the cylinder and compress it. This charge of gas under compression becomes explosive and will ignite from the hot tube. The engine then turns and the charge is fired each time as it is compressed to the explosive state. The heat of the burning gas is sufficient to keep the tube hot. To secure the best results the time of igniting must occur at different positions varying with the speed and the quality of the charge. There is a difference in time between the igniting and the total combustion of the charge. This lag with equal quality of mixture remains constant with varying speed, which necessitates having a means whereby ignition will occur earlier for the higher speeds and later

for the lower speeds in order that the force of the expanding gas will be applied to the pistons in their most efficient position. For this reason the hot tube ignition is confined to the constant-speed stationary engine.

Make and break was the first type of electrical ignition. The equipment consisted of a coil of about 200 turns of No. 16 to No. 20 insulated copper wire wound around a soft iron wire core, a contact device inside the cylinder operated by a cam mechanism driven by the engine to close and open the contacts at a set time, a switch and a source of direct-current, either battery or electric generator. When the contact, Fig. 1, is closed a current of from two to five amperes flows through the coil; when the contact is opened, the sudden break in the circuit causes an inductive kick, forming an arc ⅛ to 5/16 inch long between the opening contacts, thus igniting the charge. To obtain different positions of ingiting required a complicated mechanism. There was much trouble experienced by gas leaking around the movable rod protruding through the cylinder walls. It was also difficult to keep the contacts clean from carbon and from burning. The moving parts were necessarily heavy and noisy and a large number of parts were required for multiple cylinders.

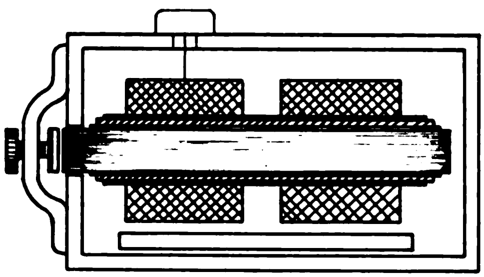


FIG. 2

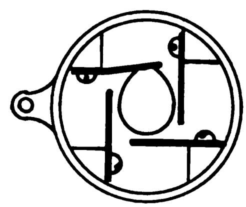


FIG. 3 1707

FIG. 2. VIBRATOR COIL FOR JUMP SPARK IGNITION.
FIG. 3. ROTATING CAM FOR TIMER FOR JUMP SPARK IGNITION.

Jump spark ignition, as it was termed at that time, was next in the line of improvements. With this system the contacts were brought outside the cylinder, eliminating the leaky movable rod, and burned and dirty contacts, and in place a spark plug was used. It was thus easier to get the timing range necessary for the different positions of igniting. The equipment necessary was one coil for each cylinder with a primary winding of about 200 turns of No. 20 wire, over which was the secondary winding, usually of two sections, with a total of about 15,000 turns of fine wire (No. 35), a vibrator being connected in series with the primary circuit of this coil, Fig. 2; a low-tension distributor with as many points as cylinders, the cam rotating at one-half engine speed for four-cycle engines, Fig. 3; a spark plug for each cylinder, a switch and a source of energy. Fig. 4 shows the jump spark connections. Contact is made in the low-tension distributor. This connects the source of electrical energy to the primary coil, the vibrator contacts, distributor and to ground and back to the source, completing the primary circuit. When the primary core is sufficiently magnetized, the vibrator contacts are opened, breaking the primary circuit and inducing in the secondary winding a very high voltage kick. The continued vibrations will send a shower of sparks across the spark plug gap as long as the low tension distributor contact remains closed. The portion of the dis-

tributor supporting the contacts is constructed so as it may be turned at different angles about the shaft, thus changing the position of ignition with reference to the engine cylinder. This gives the timing range necessary for setting the spark to the most efficient position.

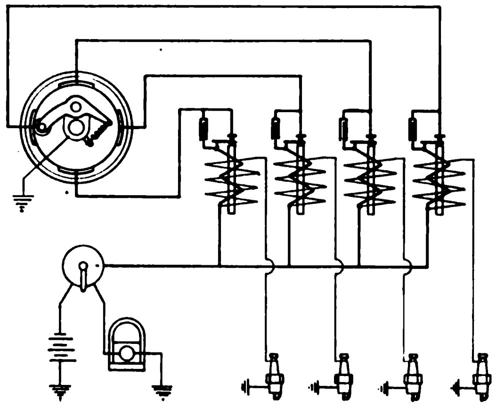


FIG. 4. DIAGRAM OF JUMP SPARK SYSTEM 1798

At this stage of the development the magneto was beginning to be used extensively in addition to the batteries. The necessary renewals of dry cells when used continually became objectionable and so the batteries were only used at low speed and when starting the engine, as the magneto did not generate enough current when running at low speed to supply the ignition. A switch was arranged on the dash to change it from one to the other as desired by the driver. Still the ignition was not right and the rapid improvements in the engine showed all the more that further improvement was necessary. It was found impossible to adjust the different vibrators to get smooth firing, especially at the higher speeds, and the tendency of

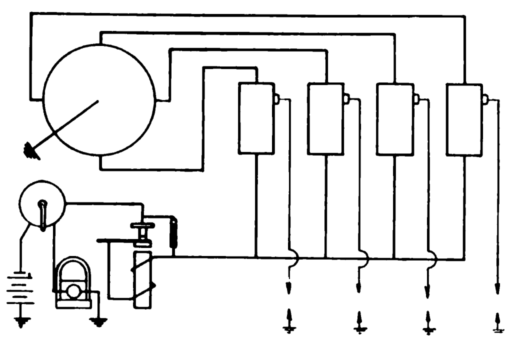


FIG. 5. MASTER VIBRATOR SYSTEM 1799

engine design leaned toward the higher-speed engine. The trouble was in the coil and the vibrator. The coil core took a certain length of time to magnetize. One vibrator would open the contacts sooner than the other. This would cause an uneven running of the engine, and the effect was modified for high speeds.

The Master Vibrator, which controlled all the coils from the one vibrator, came next. It gave a uniformity in the time of firing and the engine would operate very smoothly when the proper adjustment of this one vibrator was obtained. This scheme is shown in Fig. 5. Experimenting with the master vibrator system brought about still another improvement. Making the magnetic circuit of the master vibrator of slower magnetizing material

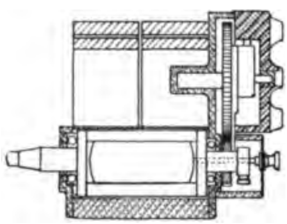


FIG. 6 LOW-TENSION MAGNETO

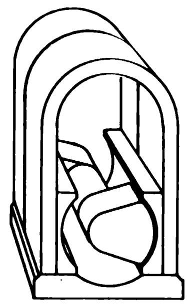


FIG. 7 INDUCTOR TYPE ARMATURE

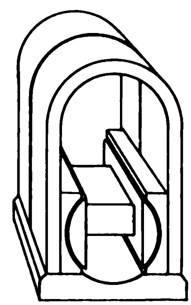


FIG. 8 SHUTTLE TYPE ARMATURE 1800

as compared with the primary core, the primary core could be totally magnetized before the vibrator contact would open. This gave the first spark a very large amount of energy, and it was noticed that this spark alone was sufficient to ignite the charge, and by eliminating the following sparks no perceptible loss of power was noticed in the engine.

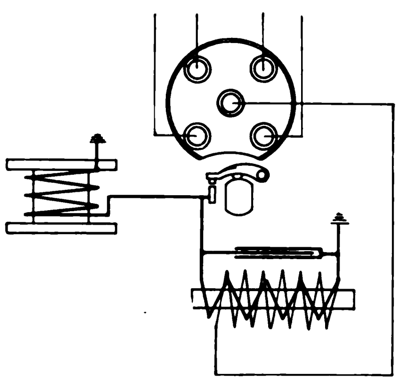
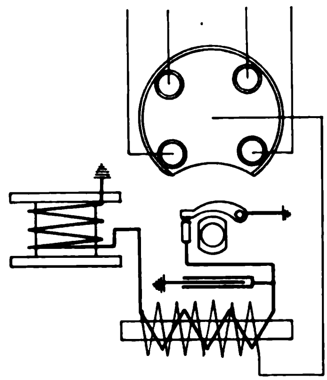


FIG. 9. CLOSED CIRCUIT TYPE MAGNETO 1801

The Single Spark system of ignition made use of an interrupter instead of the master vibrator. This was placed on the end of the magneto and a cam on the same shaft opened the interrupter contact the same as did the master vibrator, except that it was opened without any lag and occurred at exactly the same angle regardless of the engine speed. The interrupter could also be adjusted for advance and retard position. The low-tension distributor at this stage practically disappeared, and in its place came the high-tension distributor,which eliminated all but one coil. The interrupter and high-tension distributor were assembled on the magneto, which now took the lead, Fig. 6. The commutator and brushes were discarded and the alternating current was used, arranged so that the time of break in the

interrupter occurred at the peak of the wave. The magneto armatures were of two different types—the inductor type, Fig. 7, and the shuttle type, Fig. 8. The connections were generally by two different methods, Figs. 9 and 10.



1802
FIG. 10. OPEN CIRCUIT TYPE MAGNETO

The High-Tension Magneto was the last important improvement in magneto design, being connected as shown in Fig. 11. Winding the secondary coil on the magneto armature was an improvement over the low-tension magneto in three ways—first, it eliminated the primary winding and core (as the magneto winding performed its functions), therefore eliminating the losses in these parts; second, the generation of energy in the secondary

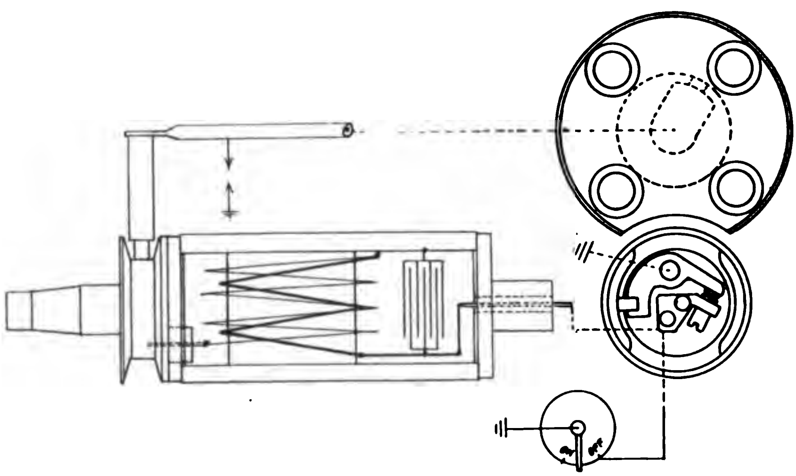


FIG. 11. HIGH-TENSION MAGNETO CONNECTIONS 1803

winding within itself by cutting the lines of force in the magnetic field added to the efficiency; third, it allowed building an interrupter in which the contact pressure increased with increasing speed.

Battery Distributor Ignition.—The appearance of electric starting and lighting on the automobile has brought about more possibilities in the improvement of the ignition apparatus. The storage battery, used in con-

nection with the starting and lighting systems makes a comparatively large supply of electrical energy from which to take the ignition current. The connections for the battery ignition system are shown in Fig. 12. The high-tension distributor and interrupter are mounted in the same unit and stand in a vertical position, driven directly from a shaft on the engine or from the lighting generator shaft. It rotates at one-half engine speed, and since the interrupter cam and moving part of the distributor are located on the same shaft, the cam will have as many lifts as the number of engine cylinders. The general appearance of such a unit is shown in Fig. 13. The coil condenser and ballast resistance are usually assembled together in a 2.5 to 3 inch tube and mounted on the dash or on the engine near the distributor. The switch is sometimes mounted on the end of the coil, and in

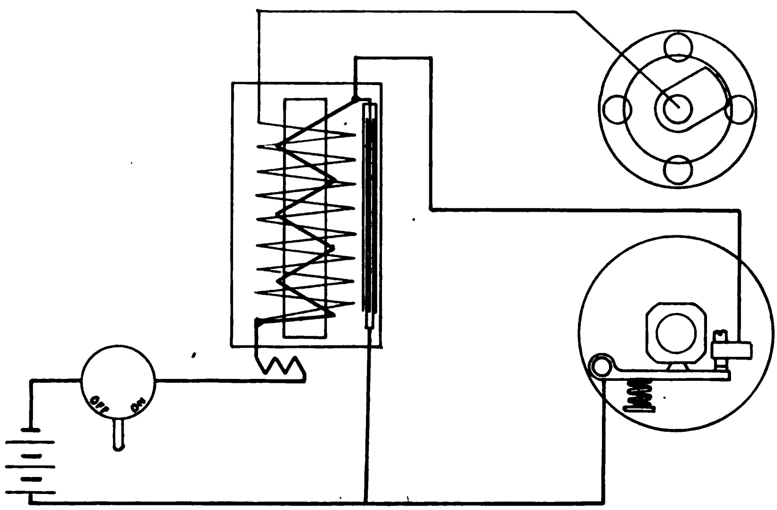


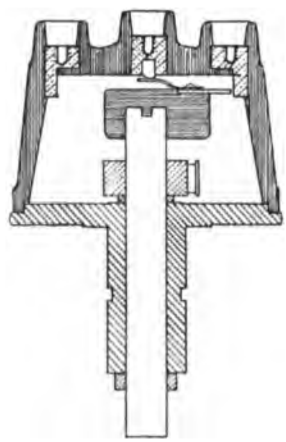
FIG. 12. BATTERY DISTRIBUTOR SYSTEM 1804

this case the coil must be mounted on the dash in such a manner as to allow the switch to become flush on the dash or cowl-board, but usually the switch is separated to enable mounting it in the most accessible place for the driver.

High-tension distributors are made in two forms:—first, with a brush to carry the current from the rotating member to the proper terminal on the fixed member or distributor cap; second, instead of the brush a metal part of the rotating member has a small clearance between it and the terminal on the distributor cap. The current will jump this gap and carry the spark to the proper cylinder. It is, however, hard to determine which is the better principle, as the advantages of one are offset by those of the other. For instance, the disadvantage of the distributor without brushes is the energy spent in spanning the gap. This is equally ballanced by the wear on the brush and brush track, the greater number of parts and the leakage due to carbon dust from the brushes upon the insulated parts.

The interrupter is made in four different constructions, each one having their good and bad features. To understand the reason for the different types of interrupters it is necessary to understand the characteristics of the battery ignition system. To get complete magnetizing of the induction coil iron core, a certain time of contact is necessary in the interrupter. Less

time will allow the interruption of the circuit to occur before the core has taken in its rated capacity of energy and the igniting spark will be correspondingly weak. A larger time of contact will be energy wasted in the coil, which will appear as heat. Also for best results it is necessary for the firing of the charge as described above to occur earlier for higher speeds and richer mixtures. Stopping an engine with the contacts in closed position and a switch closed will be liable to discharge the battery or burn out some portion of the ignition circuit if left long enough. Hence an ideal interrupter would first be simple in construction and reliable; second, have an equal time of contact with varying engine speeds; third, have automatic advance with increasing engine speed and gasoline mixture; fourth, have a contact which cannot be left in the closed position in case the switch is left closed with the engine not running.



1805

FIG. 13. BATTERY DISTRIBUTOR AND INTERRUPTER

The most commonly used interrupters of the present date are shown in Figs. 14, 15, 16, and 17, of which Fig. 14 is the most simple and reliable construction, and for that reason is greatly used. However, the time of contact varies inversely with increasing engine speed, and it is found necessary to make the moving parts light in order to keep an equal angle of contact with the increasing speed. If the lever is unable to follow the cam on the descending side there will be additional time loss added to the actual calculated decrease in time of contact. With this interrupter the ignition spark will be found to decrease with increasing speed. This interrupter causes a straight line firing, i.e., there is no lag in the position of firing, as there is with the other types as shown above. The interrupter shown in Fig. 15 is very commonly used. This interrupter has a slight increase in angle of contact with increasing engine speed; also a lag in the firing position. The increased time of contact will be in proportion to the weight of the lever and the quickness of the contact spring. The break is made on the descending side of the cam lift instead of on the ascending side as in Fig. 14. In operation the lever is raised by the cam lift, and if the action of the spring is quick enough to follow the motion of the lever when going up the lift of the cam, contact will then be made on a straight line position (not the firing

position). It is then necessary for the lever spring to cause the lever to follow the descending side of the cam. Due to the weight and the momentum gained in the lever on the upward motion at high speed, the spring is unable to move the lever quick enough to eliminate the lag in the firing position of the interrupter. With this type of interrupter a wider angle of

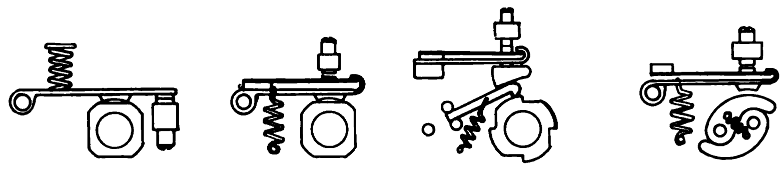


FIG. 14 FIG. 15 FIG. 16 FIG. 17 1806
FIGS. 14-17. DIFFERENT TYPES OF INTERRUPTERS

timing range is provided, and in some cases automatic advance is given in addition to the manual advance to make up for the lag of the interrupter. In Fig. 16 is shown a type of interrupter which accomplishes two of the requirements of an ideal interrupter, equal time of contact and the impossibility of not stopping on contact, but has the lag as mentioned above, and also is of a delicate and complicated construction. The total angle of contact in this type of interrupter is all lag, and since the time of contact remains constant the angle of contact increases with increasing speed, and likewise the angle of lag increases with the increasing speed. If the engine is set to fire on dead center (not considering the lag in the motion of the pawl), contact will always be made at dead center position of the engine, but the angle at which the break will occur will depend on the speed of the engine and the

1807
FIG. 18. WESTINGHOUSE VERTICAL IGNITION UNIT FOR MOUNTING DIRECTLY ON A FOUR-CYLINDER ENGINE

time of contact of the interrupter. Hence at very low engine speeds the angle of contact becomes infinitely small, and with increasing speeds it increases very rapidly. Thus the time of contact is limited to a very small amount, to keep a minimum lag. This necessitates building a coil of the quick magnetizing type and reducing the resistance of the primary circuit

as far as possible to allow the coil to store enough energy in the short length of time provided.

The interrupter shown in Fig. 17 possesses to some extent three of the requirements of an ideal interrupter—increasing angle of contact with increasing speed, simple construction and automatic advance—but retains the possibility of stopping with the circuits closed. This possibility is much less than is found in the types in Figs. 14 and 15, since the angle of contact is very small at low engine speed, and thus there is a greater chance of stopping in the open position.

FIG. 19. DETAILS OF IGNITION UNIT 1808

The ignition coils are made up of one general type, a primary coil and core, and secondary connected as in Fig. 12. The ballast resistance is connected in series with the primary coil, and its effect on the system is to equalize the high and low speed spark energy.

The switches are made to accomplish different features, such as reversing the direction of current through the interrupter alternately as they are turned off and on again to reduce the building up and pitting of the interrupter contacts. Also they can be built so as to open the circuit automatically in case the ignition switch is forgotten in the *on* position when the engine is stopped with the interrupter contacts closed. It is also found to be an advantage to equip the switch with a locking device to protect the car from theft. —*The Electric Journal.*

✣ ✣ ✣

AERONAUTICS

Sturtevant All-Steel Battle Aeroplane Makes Successful Flights.—The all-steel battle aeroplane constructed by the Sturtevant Aeroplane Co., at Jamaica Plain, Mass., after a design entirely new in aeronautical engineering, was flown at Readville, Mass., on Sunday of last week.

Henry Woodhouse, a Governor of the Aero Club, who has watched the development of this type of machine from the day that the plans were drawn, gave the details of its construction and performances under test to a reporter of the New York *Times.*

"This is perhaps the greatest development of the battle-plane yet made," he said, "and its adoption by the Government will place the United States in a position to lead the world. Its most novel features are the gun turrets.

"The machine is a biplane, about fifty feet over all on the wings, an owing to its vanadium steel construction is of exceptional strength. Unl any other design now in use for gun-bearing aeroplanes, the gun turret placed at the far ends of the wings. They are, roughly, eight feet l two and one-half feet wide, and will hold a rapid-fire gun and its

with ease. The great advantage this design gives is that it will allow the gun a vertical arc of fire of more than ninety degrees, while the horizontal arc is well over 200. These guns will be heavy enough to destroy other aeroplanes or dirigibles, and combined with the bomb equipment will make the United States battle-plane a most efficient engine of war.

"The vanadium steel construction is another great advance in aero construction. The entire plane is of this steel, which is lighter than wood, and it has this advantage combined with much greater strength. It is built of a number of steel units; that means that the size of the aeroplane can be increased to any reasonable extent, even as great as 500 feet across the wings. All these units are standardized and are stamped out by machines of similar design.

"The constructor can build the machines just as a child puts one of those mechanical building toys together. It is only a question of deciding the use to which the aeroplane is to be put, and then he goes ahead and builds a machine of the carrying power and strength that is needed. For war use, this feature will be of inestimable value and will obviate the troubles that crippled the air squadrons of the Allies at the beginning of the war when machines were laid up for weeks at a time on account of lack of parts.

"The motor used is 140 horsepower, and, like the machine, was built by the Sturtevant Aeroplane Company, Boston. It is the regular type aviation motor and can be built to any horsepower required. Grover C. Loening of this city, who was formerly chief aeronautical engineer of the United States Government, and who resigned last summer for the purpose, designed the new battle-plane. He has had a long experience in aeronautics, and started with the Wrights.

"Although designed primarily for military purposes, the new plane will be very useful for mail and express carrying. Instead of placing guns in the turrets, mail or express packages may be packed in them, and special weather-proof containers have been built for this purpose. The weight-carrying capacity of the new machine has not yet been announced, but it is known that each turret can hold more than 500 pounds with safety and without lessening the speed.

"Compared with the aeroplanes now being sent to Europe, this machine is about the same size as the 'Canada' class being built by the Curtiss Company in Toronto for the British Government. These have been very efficient and it is expected that the new two-turret flier will rival their record."

—*Aerial Age Weekly.*

Eighty-four Aeroplanes in a Squadron.—The impressive flight of eighty-four French aeroplanes speeding away for an attack on the German line was witnessed near Nancy by an American war correspondent.

"There was a sudden crack of a revolver, the mechanics and helpers at the front line ducked away, there was a sudden rushing of mighty wings, and the first line of twenty machines leaped across the field and rose simultaneously in the air, followed by the larger ones. They arose right in the path of the sun, which made their wings glisten as they turned to the right, hovered a moment, then started east.

"Then again came the sudden rustling of giant wings, and a second twenty machines, in a perfect line, followed by a great hawk, sped across the field and lifted themselves into the sky. The sun shot its glittering rays among their wings.

"On the sixtieth second came a third shot, and in just four minutes eighty-four aeroplanes were in the sky. Looking at certain angles one could see each squadron sharply defined from the others, followed by its hawk, which was always slightly higher in the air. At other angles of vision they all converged in a giant flock.

"At the end of the fifth minute they were just tiny dots in the sky, all flying at full speed due east in the direction of the German lines. At the end of the sixth minute they were gone.

"After an hour the colonel in charge turned his glasses skyward into the east. Finally a faint speck appeared away off in the midst, then another, then another, clearer and clearer, until they evolved into aeroplanes. They were coming back single file, so that the observers left behind could count them as they came to earth.

" 'Sometimes one or two do not come back,' the colonel explained. 'We always count them carefully.'

"They came on at terrific speed, the bigger aeros flying higher, preparing for a volplane into the center of the field, but the smaller ones flew low, all headed for one end of the field."—*Flying.*

Germany in For Air Supremacy.—Baron Cederstrom, a director of the Swedish government aeroplane factory, who has been visiting aviation centers in Germany, is authority for the statement that aeroplane construction in the latter empire is undergoing a complete revolution. Heavy machines are taking the place of light ones. The new machines are capable of carrying immense loads, including guns, wireless apparatus, petrol bombs and signalling devices.

Describing one such machine on which he made a trip, the Baron said it was a giant battle-biplane of improved design and enormous dimensions, nearly three times the size of the ordinary albatross type, with immense lifting power, great stability and notable speed, and carrying an unprecedented weight of armor, artillery, petrol and provisions with a very large crew.

As can be seen the German Empire is actively engaged in leading in the aerial race that has just started among the fighting great powers.

Not only are there already many twin and triple-screw battle-planes in commission and still more under construction; the development of the airship is also fostered with incessant care.

The Rotterdam correspondent of the London *Daily Telegraph* claims to have absolute information to the effect that Germany is devoting more energy to the construction of Zeppelins than ever before. In a score or more widely separated places the construction of Zeppelin dirigible balloons is being carried out, and that in no department of constructional work in Germany is greater activity being shown.

Dirigibles of all types—Zeppelin, Parseval, and Schutte—are being turned out with feverish haste, the correspondent understands. New sheds are being built, not, as formerly, of easily combustible wood, but of iron, including roofs of the same material, as a protection against aircraft attacks. The Krupps also are said to be engaged in building portable sheds.

From all the correspondent was able to learn, the idea is to bring the war home to the English people, who, hitherto, "have not felt its effects, so that they shall be more anxious for peace."—*Flying.*

France Has Four-Engined Aeroplanes.—Some more details are now available concerning the new battle aeroplanes the French government is building with great haste in view of a big aerial offensive against Germany which is scheduled to take place some time next spring.

The report at hand says:

Multiple powered biplanes are much in favor with army constructors. Two such machines which recently left Buc flying field for the front, astonished some observers by their ability for speed and climb. At Saint Cyr repair station there is a machine of this type which had been hit by a German shell. One motor had been demolished, the observer had been killed and the pilot wounded, but the latter was nevertheless able to bring the machine back to the French lines with the remaining motor, thus demonstrating the possibilities of multiple motored machines in warfare.

France has under construction a number of four 120 horsepower Anzani motored tractors with a spread of 90 feet, the motors being in a line along the leading edge. These machines will carry guns throwing an explosive shell.

There are no less than 200 pupils in daily training at the Buc flying field, with an average course of two months.

"At Issy," writes a recent observer, "the Voisin machine is most prominent and more noticeable is the giant triplane equipped with four 140 horsepower Salmson motors in tandem, two on each side of the fuselage, with a spread of nearly 120 feet, a massive machine seating eleven people comfortably." Although still in an experimental stage this machine is doing very well.

The general tendency in France is toward a multiple motored high powered weight carrying machine with a moderately high speed, equipped with guns of the explosive shell type.—*Flying.*

Huge American-Built Battle-Planes for Allies.—It is announced by the officials of an American aeroplane manufacturing company that orders have been placed by the Allied governments for 11 huge battle-planes of most modern design. Each aeroplane will weigh in the neighborhood of 30,000 pounds, and the frame work will be entirely of steel. It is said that the wing spread is to be 180 feet, while the length of the aeroplane from tail to propellers will be 104 feet. The framework will be constructed on the cantilever truss principle, insuring great strength with a minimum weight. Twin bodies will be used, each body carrying an engine of 800 horse-power. It is planned to arm the machines with four guns, two fore and two aft, of a caliber of between 1½ and 2 inches, and capable of firing 20 to 40 shots per minute. Each airship will carry a number of bombs of any size up to 14 inches in diameter. The specifications call for a speed of 85 miles an hour with full load and a crew of six men.—*Scientific American.*

NOTICE

The JOURNAL U. S. ARTILLERY desires to receive from its readers, titles of subjects which they consider would be of interest to the service. The following has been suggested:

National Guard Coast Artillery: Armory Instruction, and Preparation for Service Target Practice and Service Conditions.

BOOK REVIEWS

The Military Unpreparedness of the United States. (A History of American Land Forces from Colonial Times until June 1, 1915.) By F. L. Huidekoper. New York: The Macmillan Company, 64 Fifth Avenue. 6½" x 9¼". 735 pp. 16 maps. Cloth. 1915. Price, $4.00.

Frederick Louis Huidekoper, the author of *Military Unpreparedness of the United States* or, as it is perhaps more properly called on the title page, *A History of the American Land Forces*, was graduated from Harved University in 1896. He studied military history under John Codman Ropes, the author of *The First Napoleon, The Waterloo Campaign*, and other military works. He later spent considerable time in Paris making a special study of Napoleon's campaigns for which purpose the French Government gave him access to its official records. Prior to this recent work on unpreparedness he contributed various articles concerning military questions to leading magazines and papers, all of which have shown intelligent and extended observation. As a further qualification to express opinions worthy of consideration, his presence in Europe during the Fall of 1914 gave him an opportunity to witness the early operations incident to the mobilization of troops in several countries now engaged in war.

He attended the Military Instruction Camp at Plattsburg in the Summer of 1915.

His reasons for publishing a book on unpreparedness were the lack of a complete Military History of the United States and the apparent need for one which would give the "unvarnished truth" without suppression of the "blunders which have characterized our military policy in the past." He has taken General Upton's book as a model, giving to him credit for "one of the most masterful works of the sort in any language."

The introduction of Mr. Huidekoper's book is written by General Leonard Wood, U. S. Army, who says in part: "This work is one that should be read, and carefully read by all Americans who are interested in the military history and policy of their Country, and who desire to replace our past haphazard policy by one which will be adequate to secure a reasonable degree of preparedness without in any way building up a condition of militarism. Mr. Huidekoper presents with such effectiveness the folly of our past policy and its great and unnecessary expense in life and treasure, that one who reads with an average degree of intelligence cannot escape the conviction that a continuance of the policy of unpreparedness, blindly trusting to chance, which has characterized and dominated our military policy in the past, and a continuance of the methods employed in raising and maintaining armies, can have but one end—"national disaster."

The contents of the book are arranged in chronological sequence, statements of historical facts connected with our military operations being carefully enumerated, followed by weaknesses developed with conclusions drawn

as to lessons which should have been apparent but which were disregarded in subsequent legislation. Copious notes pertinent to the subject matter presented are cited and arranged for convenient reference in an appendix.

A study of this book impresses the reader with an almost innumerable array of glaring errors which have repeatedly characterized our military legislation. Those so apparent as to verge upon criminal neglect may be summarized as:

Lack of definite military policies causing military legislation at the outbreak of war to supersede military action.

A non-expansive military establishment in time of peace causing useless sacrifice of human life, unlimited waste of money, and national humiliation.

The payment of bounties to recruits.

The temporary expedient of short enlistments in time of war.

The unnecessarily large number of troops under pay, the lack of discipline, and the heavy losses from sickness in war.

Failure to recognize that any system based on the consent and co-operation of the States possesses none of the elements of certainty or of strength and causes national expenditures beyond justification.

Failure to profit by experience and to recognize that in a military system combining the use of regulars and volunteers, men, in the absence of compulsion, will invariably enlist in the organization most lax in discipline, i.e., not in the regular army.

Failure to provide for adequate trained reserves, causing dependence upon raw troops and needless protraction of all our wars owing to the inefficiency of troops employed.

The continued repetition of all of the above errors in policy having been set forth, the author concludes his work with two important chapters on the present inadequate condition of our land forces and a suggested organization to provide needed reforms.

The cardinal principles underlying military policies, he observes, are:

1. Every citizen has the right to the protection of life, liberty, and property.
2. Citizenship carries with it the obligation of military service.
3. The people want adequate national defense.
4. The responsibility of the government for public weal is undivided.
5. World power necessarily entails great responsibilities.

A proper consideration of these principles with a study of past errors suggests the following obvious provisions as necessary for adequate preparedness:

1. A peace organization in keeping with effectiveness in war, one which will permit the army as a whole to be instantaneously available for active operations.
2. The organization of all national resources so as to render them available at the outbreak of war.
3. The enlargement of the Military Academy at West Point.
4. Additional training for young men at the various military schools.
5. The extension of the system of Military Instruction Camps.
6. The registration of names and addresses of all men who have received intensive military training.
7. The placing of military finance on a budget system.

8. A definite organization of four lines of defense consisting of:
   a. A regular army of 250,000 men.
   b. A reserve for the regular army amounting to 420,000 men.
   c. United States Volunteers.
   d. The organized militia or National Guard.

Mr. Huidekoper's many excellent ideas of needed reforms are based upon weaknesses developed in our own experiences in war. It is to be regretted he did not include conclusions to be drawn from a study of recent operations in Europe. He could doubtless have impressed the public with the fact that preparedness carries with it the necessity for military legislation in order that coast and land defense projects involving the use of large caliber guns on movable mounts may be assured of military action in time of need.

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Self-Helps for the Citizen Soldier. By Captains J. A. Moss and M. B. Stewart, U. S. Infantry. Sales Agent: Journal U. S. Artillery, Fort Monroe, Va. 5½"x7¾". 239 pp. Profusely illustrated. Cloth. 1915. Price, $1.25.

Captain Moss has been a prolific writer of books intended for the service. In the present volume he has addressed a new audience. The book is dedicated "to every red blooded American who is willing to do a man's share in the defense of his country." Its purpose is to awaken a popular interest in the fighting man and to impart some rudimentary knowledge of the soldier's trade, to the people at large from whom the armies of "Citizen Soldiers" of our future wars must be drawn.

That soldiering is a difficult trade, learned only after a long apprenticeship, and that armies are complicated machines whose successful operation requires the highest degree of knowledge, training, and skill, must be apparent to the layman after reading this book.

In the third chapter is shown what it means in the matter of material supplies to keep an army of one million men in the field. This chapter is an illuminating argument for the organization of the industries of the country in times of peace so as to meet the strenuous demands of war.

The whole book is an excellent brief in support of the necessity for "preparedness" and training, and should go far toward combatting the popular belief—patriotic but pernicious—that our millions of untrained men, although without adequate supplies or experienced leaders, constitute a military asset and an adequate protection for our territorial possessions and our wealth.

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La Guerre de 1914. L'Action de l'Armée Belge pour la Défense du Pays de la Respect de sa Neutralité. Rapport du Commandement de l'Armée (Periode du 31 Juillet au 31 Décembre, 1914). Paris: Librairie Chapelot, 30 Rue Dauphine, VI. 7½"x9½". 97 pp. 11 maps. Cloth. 1915. Price, 1 fr.

This book, containing 97 pages and 11 maps, is well gotten up and is a monument to the printers art. It is interesting reading to the military student, being the official Belgian report covering the operations of the first period of the war of 1914.

The report is divided into nine chapters, entitled, respectively: Preliminary Details; The Defense of Liège; Combined Operations, Aug. 6-20; Defense of Namur; Combined Operations, Aug. 20-Sept. 27; Defense of Antwerp; Combined Operations, Oct. 6-15; The Battle of the Yser; and General Review. The titles of the chapters give an excellent idea of the scope of the book.

When the European War broke out, only a beginning had been made on the reorganization of the Belgian army which, in 1918, was to consist of 350,000 men. At the outbreak of the war it numbered but 117,000 and consisted of six divisions and one cavalry division, which in time of peace were stationed as follows: 1st Division, Ghent; 2nd, Anthwerp; 3rd, Liège; 4th, Namur; 5th, Mons; 6th and Cavalry Divisions, Brussels. The war plans provided concentration points so chosen as to enable Belgium to resist invasion from any direction.

As a result of information of German intentions received the night of August 3, orders were issued for a concentration of the Belgian army toward the eastern frontier with a view to the defense of the line of the Gette River. This movement was covered by the Cavalry Division and the 3rd and 4th Divisions, and was completed on August 5. The Belgian plan of campaign prescribed that the army should not risk severe losses against superior numbers, but should fall back covering its lines of communication and ultimately form a junction with the British and French forces.

On August 4, German cavalry crossed the frontier followed closely by seven army corps converging on Liège which was attacked. The 3rd Belgian Division bore the brunt of the attack and began retiring to join its main army on August 6. The permanent garrisons of the Liège forts continued their resistance and the last fort did not surrender until August 17.

On August 18, the main Belgian army began retiring from its positions along the Gette River in a northwesterly direction toward the River Dyle; but an enveloping movement of the Germans against the Belgian left compelled a further withdrawal on Antwerp which was reached on August 20. On the night of August 20, the attack on Namur began with a series of assaults which were repulsed. The bombardment of the forts began on the morning of August 21 and the last fort succumbed to the large caliber artillery of the Germans on August 25. The 4th Belgian Division withdrew from Namur on August 23 and reached Antwerp ten days later.

From August 20 to September 27, the Belgians made several sorties from Antwerp with the object of holding as many German troops as possible before Antwerp and relieve the pressure on the French.

On September 28, the German attack upon Antwerp began. The effect of the fire of the German large caliber artillery soon convinced the Belgians that Antwerp was untenable and preparations for evacuating it began on September 29, Ostend being selected as the new base. The withdrawal of the field army from Antwerp began on the night of October 6-7 through Ghent to the Yser where junction was made with the British and French armies on October 15. On October 9, the Germans entered Antwerp which was surrendered the next day.

The Belgians now occupied a line about 22 miles long on the Yser beginning at Nieuport at the mouth. From October 18 to 30, the Belgians, assisted by one French division, successfully withstood a determined attempt on the part of the Germans to break through the line and turn the allied

left. The operations during the remainder of the year along the Yser were reduced to local successes and failures.

The final chapter gives a general review or summing up of the operations, the strategy, the successes, and the shortcomings of the five months of war.

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The Aftermath of Battle. By Edward D. Toland. New York: The Macmillan Company, 64 Fifth Avenue. 5½" x 8". 175 pp. 16 il. 1916. Cloth. Price, $1.00.

The writer of this little volume is an adventurous young American who went to France on his own responsibility shortly after the beginning of the "Great Convulsion," and who narrates his experiences and observations as a chauffeur, hospital orderly, and operating-room assistant in a Red Cross institution in Paris and at the front.

After a brief introduction of the diary, wherein the writer describes his voyage in the steerage to Liverpool, one is plunged instantly into French chaos.

The real story begins at an improvised Red Cross hospital in Paris, and some idea is given of the state of apparent confusion in the sanitary service of the French Army in the earlier stages of the great war, and of the troubles that arose in connection with transportation and distribution of an enormous number of wounded and sick.

The fact that the military authorities did not at once avail themselves of the facilities of private sanitary institutions, at a time when an unprecedented number of patients were coming from the battle lines, would seem, at first glance, to be inexcusable official stupidity. There are, however, good military reasons for not allowing sick and wounded to be scattered among private institutions if it can be avoided. Such institutions are in a way irresponsible, and their patients are temporarily out of strict military control. A large percentage of the sick and wounded are expected to ultimately resume duty with their organization and it is important that the military authorities should keep them under direct control.

Very little martial glamour intrudes into the story even in the account of his service near the front with the ambulance corps, and the more seamy side of war is shown. An interesting side light is thrown upon the horrors of war in the description of terrible injuries and frightful suffering of the wounded. It faintly indicates what must have occurred in hundreds of institutions that were serving in rear of the extended battle lines and the humane efforts that are being put forth by the Red Cross Society in its endeavors to mitigate the horrors of war.

The book also furnishes an argument for preparedness for war, especially for the sanitary service as it shows that zeal and ardor cannot successfully replace organization and training.

The little book is interesting and well worth reading as the writer confines himself to a narration of his own experiences and observations and refrains from expressing his own views on how war should be conducted or the manner in which the sanitary service should be organized.

Journal of the United States Artillery

May-June 1916

COAST ARTILLERY SCHOOL PRESS
FORT MONROE, VIRGINIA.

JOURNAL UNITED STATES ARTILLERY
PRIZE ESSAY COMPETITION

1916

The JOURNAL U. S. ARTILLERY announces the following for its annual competition.

PRIZES

One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the JOURNAL.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the JOURNAL OF THE UNITED STATES ARTILLERY. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the JOURNAL and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

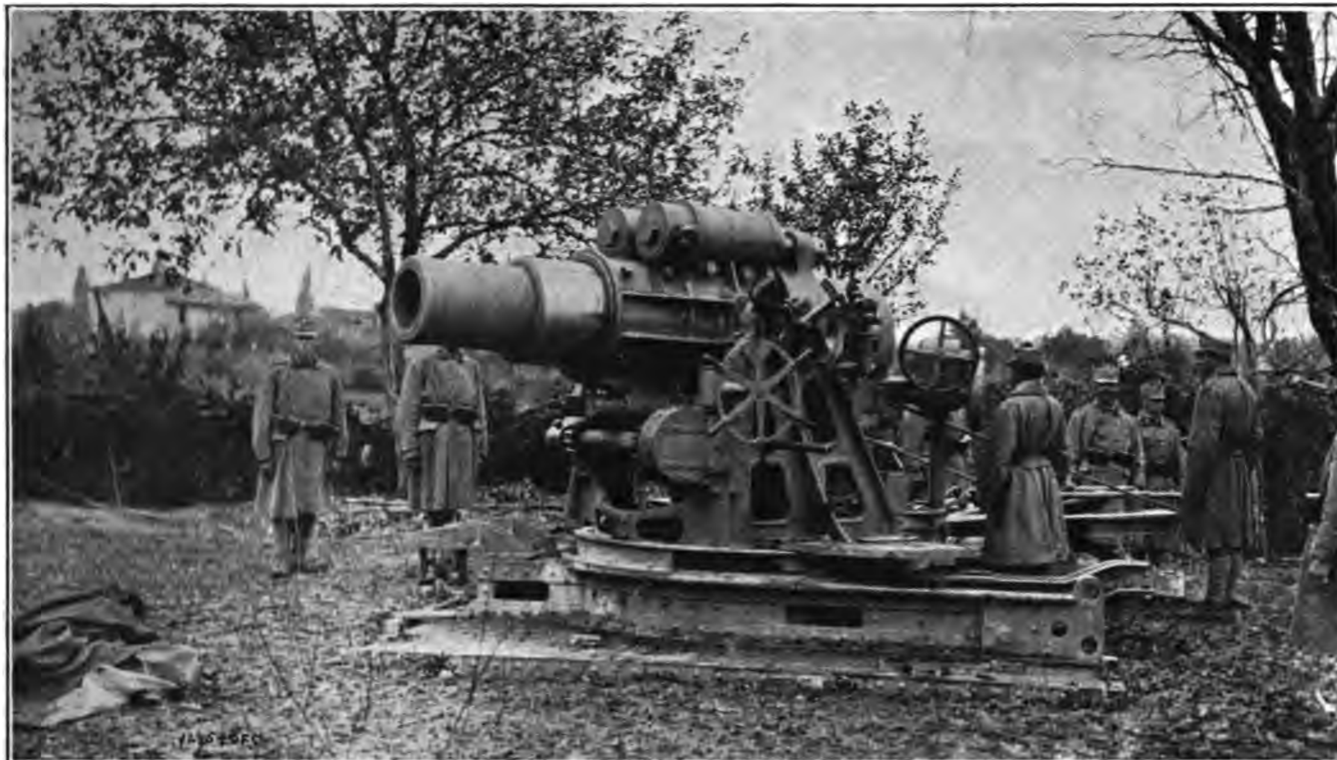
(f) Copy must be received on, or before, December 31st, 1916. It must be addressed JOURNAL U. S. ARTILLERY and the envelope must bear the notation, "Essay Competition."

NOTICE

The JOURNAL U. S. ARTILLERY desires to receive from its readers, titles of subjects which they consider would be of interest to the service. A title will be published (either on the "Prize Essay" announcement page, or immediately following "Short Notes") until a paper on that subject has been received.

The following has been suggested:

"National Guard Coast Artillery: Armory Instruction, and Preparation for Service Target Practice and Service Conditions."



AN AUSTRIAN 30.5-CM. MORTAR AT THE FRONT AGAINST ITALY

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OF THE
UNITED STATES ARTILLERY

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PREPARATIONS THAT SHOULD BE MADE IN PEACE FOR QUARTERING AND PROVISIONING COAST DEFENSE GARRISONS IN WAR

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The writer of this paper was in charge, at his station, of the Coast Artillery war game instruction during a part of the indoor period of 1914-15. Not the least of the benefits derived from the use of the war game is the promotion of discussion of various artillery subjects between officers, and the consequent dissemination of information. There were many such discussions held at the post referred to during periods devoted to the war game, and at other times. Frequently, the writer was asked such questions as the following: What is the contemplated action with reference to so and so? When is it intended to do such and such a thing? He was impressed with the many details brought out in these discussions, which are of necessity left for action at the outbreak of hostilities, and for which, so far as he is informed, no detailed plans have ever been prepared. In fact, this impression was so strong that the writer prepared a problem to be given out to the officers taking the war game course, looking to the preparation of plans for carrying out these details.

Before anything was done in this respect, however, the writer's station was changed; he was given new duties, which did not bring him into close touch with the war game instruction and, consequently, the matter was dropped. Upon

reading the subjects presented for the annual competition in the JOURNAL OF THE UNITED STATES ARTILLERY, this problem is again brought to mind, as it is thought a solution thereof will supply a plan for "quartering and provisioning coast defense garrisons in war," as well as for many other necessary and equally important details.

As one contemplates existing conditions in our coast defenses regarding preparedness for war, one connot but be impressed with the lack of actual readiness in many respects.

The subject of this paper, while of great importance, is only one of a number of matters which must of necessity be left for action at the outbreak of hostilities. In fact, there are so many of these details which will require attention during the period between the outbreak of hostilities and the appearance of the enemy's fleet, that it would seem to be a matter of vital importance that detailed plans be prepared in time of peace to insure their proper execution when the time arrives.

Coast defense garrisons in war will consist of:

1. Regular Coast Artillery.
2. Coast Artillery Reserves.
3. Coast Artillery Supports.

In the letter from the War Department to coast defense commanders, transmitting the projects for land defense by the Coast Artillery Supports, coast defense commanders are informed that the camps for the Coast Artillery Supports, as well as the camps for the Coast Artillery Reserves, are for a part of their war commands, and that they (the coast defense commanders) are charged with directing the work at the outbreak of war of constructing these camps in accordance with the plans prescribed in the project. These plans are general in character and coast defense commanders are directed to have constantly ready a working scheme for doing the work with the available material and labor in the shortest possible time at the outbreak of war.

If coast defense commanders have carried out these instructions, it would appear that there should be on hand at each coast defense headquarters a plan of some sort for construction of camps to quarter all troops which will comprise the coast defense garrison, as it is hardly likely that any coast defense commander would prepare plans for quartering the Reserves and Supports and not provide for his own Regular troops. Some practical ideas as to the necessities in connec-

tion with quartering and provisioning the Regular Coast Artillery troops should have been gathered from the annual encampments of those troops at or in the immediate vicinity of their batteries, stations, etc., required by the *Coast Artillery Instruction Order*. It is questionable, however, whether or not anything has been accomplished in the majority of coast defense commands in the way of actual preparation of detailed plans for quartering or provisioning these troops in war. Little has been learned in this respect from the encampments of the Coast Artillery Reserves, since, for the most part, these troops are assigned for instruction and target practice to the same batteries as are manned by the Regular Coast Artillery troops, and are placed in the same camps as are occupied by the latter troops, or, as is frequently the case, they are encamped without regard to the location of the batteries to which they are assigned and entirely with a view to keeping battalion and regimental organizations intact.

It is entirely outside the subject of this paper, but the writer cannot refrain from suggesting, in this connection, that the assignments to batteries of organizations of the Coast Artillery Reserves should, in connection with the assignment of the Regular Coast Artillery, be such as would best man the armament for war, and, so far as possible, all instruction and target practice of both classes should be held at the batteries in accordance with such assignments; otherwise, at the outbreak of war, a large portion of our troops will be required to man elements of the defense, with which they are more or less unfamiliar. Some officers will say that this is a matter of little importance but the writer submits that such a condition will but add to the difficulties of passing from a condition of peace to a condition of war, and all must admit that every possible arrangement should be made in time of peace to facilitate passing to a state of war.

The writer has seen plans worked out in a certain Coast Defense Command, under the direction of the Coast Defense Commander, for quartering all the Coast Artillery Troops Proper and the Coast Artillery Supports in time of war. These plans are prepared in the minutest detail. They contain complete lists of material required: lumber of various sizes, nails, water piping, faucets, etc.; the number of overseers, carpenters, carpenter's helpers, plumbers, two and four horse teams, drivers, cooks, laborers, etc., and their pay; just where the materials are to be purchased and where the personnel is to be

hired, and by whom. They contain detail drawings, etc., of the work to be done and, finally, they are arranged in such manner that, at the outbreak of war, the Coast Defense Adjutant simply sends one portfolio to the Coast Defense Quartermaster who is charged with purchasing the materials and hiring the labor, and one portfolio to each Fort Commander who is charged with the execution of the work to be done at his fort.

One needs but to see the amount of work involved in the preparation of these plans to realize the almost insurmountable difficulties involved in a satisfactory solution of the problem of planning this work at the outbreak of war, when the carrying out of the many final details of preparation will require the utmost efforts of everyone, both officers and men, even though carefully prepared plans for the work are on file for use at that time.

In time of war, companies of the Regular Coast Artillery and of the Coast Artillery Reserves will necessarily be divided into detachments for the purpose of manning various elements of the armament to which they are assigned; these detachments being of various sizes and, in many cases, widely separated. The best method of quartering these detachments is a local problem in each case. For instance, the manning party for a detached station may, in one case, be quartered in the station itself, available space permitting, or it may be necessary to provide separate quarters, either in tents or otherwise; in another case, there may be a group of stations in a detached position, in which case, if the personnel cannot be quartered in their stations, it will probably be advisable to quarter all of them together. In some localities it may be feasible to quarter men in tents, whereas, in other localities, due to weather conditions, it may be necessary to provide more substantial quarters.

Likewise, the matter of provisioning such detachments is a local problem. In one case, such a detachment may be on duty in the vicinity of the mess of another organization, when the members of the detachment should be attached to such organization for rations; or they may be so situated as to necessitate their being rationed separately, when the problem becomes more difficult since it is no easy task to properly provision say two men alone for any considerable time.

Each and every case will require its own treatment and should be carefully considered in time of peace, and detailed plans should be prepared for execution at the proper time. *Fur-*

ther than this, these plans should by some positive means be kept up to date. This latter is an important point and should be provided for as it is more than likely that such plans will from time to time require changes in some particulars, and such changes must be made if the plans are to be useful when needed.

The following is suggested as a means whereby plans, such as are indicated above, for quartering and provisioning our garrisons for war, as well as for many other equally important matters, may be prepared in detail in time of peace and, thereafter, kept up to date and in such shape that they will be of use when required.

In each coast defense command let the coast defense commander give out at the beginning of the Indoor Period to the officers of his command, who are not engaged in connection with the garrison school course, some such problem as the following.

Post Graduate Course

PROBLEM

At the outbreak of war between the United States and any first class power, the many details of final preparation in any coast defense command will require the utmost efforts of all Coast Artillery troops, both officers and men.

In time of peace and at comparative leisure, it is thought that a manuscript should be prepared, setting forth under appropriate headings all matters which will require attention at that time and which can be foreseen, giving details wherever possible for the accomplishment of the ends desired, thus systematizing the work and saving those responsible therefor from the necessity of planning these details at a time when, due to the pressure of business and the natural tension caused by the contemplation of possible attack, many of them might be overlooked or neglected until too late.

With this end in view, this problem is given to the officers participating in the Post Graduate Course. The final solution will be kept on file at Coast Defense headquarters and will be studied each year as a part of the Post Graduate work, with a view to necessary revision.

Required

A statement of the details of preparation, which will require attention at the outbreak of hostilities, under the following headings, and any others which may suggest themselves:

1. By the Coast Defense Commander in person or through his Adjutant:

a. Coast Defense order, announcing that a state of war exists and giving general directions and information. (Prepare a form for this order, if practicable.)

b. Reception of Reserves and Supports and conducting them to their proper posts.

c. Steps to be taken in connection with the service of information. (Give form for an order or orders, if thought necessary or desirable.)

d. Orders regarding watchers in various stations and the transmission of information. (There should be kept on duty only such watchers as are necessary to insure timely information regarding the approach of the enemy, thus giving the greatest amount of rest possible to the command.)

e. List of names of non-commissioned officers suitable for volunteer commissions in the Coast Artillery Corps, and duties for which they are suited.

2. By the Coast Defense Quartermaster:

a. List of civilian skilled and unskilled labor needed for various purposes—building camps, trenches, stockades, etc.—where it is to be procured and prices to be paid.

b. List of materials and tools necessary in the construction of camps, defensive works, etc.; where they are to be procured and the cost.

c. List of boats necessary to be hired for all purposes, showing boats available and prices.

d. Arrangements for procuring uniform clothing for increased garrison, if any such arrangements are necessary.

e. Arrangements for procuring food for increased garrison, if any such arrangements are necessary.

3. By the Coast Defense Artillery Engineer:

a. List of additional enlisted specialists needed and, if not available, how the positions are to be filled.

b. List of additional material necessary and how it is to be procured.

4. By the Coast Defense Ordnance Officer:

a. List of additional personnel—ordnance sergeants, ordnance machinists, etc.—needed and, if not available, how the positions are to be filled.

b. List of additional material necessary and how it is to be procured.

5. By each Fort Commander:

a. How would the Fort Commander inform the members of his command that a state of war exists—verbally, or by means of a written order? (If by the latter means, give a form for this order if practicable.)

b. Order for troops to encamp at war camps.

c. Reception of Reserves and Supports, conducting them to their camps, etc.

d. Assignment of the details of the work necessary in preparing camps, building stockades, digging trenches. (Prepare a blank order for this, if necessary or desirable.)

e. Orders regarding watchers in various stations and the transmission of information. (There should be kept on duty only such watchers as are necessary to insure timely information regarding the approach of the enemy, thus giving the greatest amount of rest possible to the command.)

f. Locations for quarters of the members of the manning party for the Fort Commander's station.

g. Messing arrangements for same.

6. By the Mine Commander of each Mine Command:

a. Additional boats necessary for all purposes.

b. Boats available for hire. (Should they be procured by the Mine Commander or by the Coast Defense Quartermaster?)

c. Location for quarters of the members of the manning party for the Mine Commander's station.

d. Messing arrangements for same.

7. By the Fire Commander of each Fire Command:

a. Location for quarters of the members of the manning party for the Fire Commander's station.

b. Messing arrangements for same.

8. By the Battery Commander of each Battery.

a. Location for quarters of each element of the manning party.

b. Messing arrangements for each element of the manning party.

c. Arrangements for fusing projectiles where necessary.

d. Emergency fire control.

REMARKS

The headings given are those which have occurred to the writer as the result of his experience in preparations for War Condition Periods and of discussions such as those mentioned above. There are doubtless many other matters which will suggest themselves to the various officers engaged in the solution of these problems. The writer is convinced that these plans cannot be prepared with too much attention to detail.

The problem might conveniently be solved as follows: Assign the different requirements to committees selected from the officers participating in the solution of the problem in accordance with their special qualifications. Each committee would prepare a tentative plan for its share of the problem. These various plans would then be considered by the full committee, after which the whole plan would be put into such shape that, at the outbreak of war, each officer—Coast Defense Commander, Fort Commander, Fire Commander, Battery Commander, Quartermaster, etc.—may be handed a portfolio containing detailed information as to the matters requiring his immediate attention and how they are to be accomplished. Each one of these responsible officers should be familiar with these plans beforehand, the instructions here provided for being merely a reminder list.

It is not thought that this procedure would operate to deprive any officer of the exercise of his own initiative, but that it would make it possible for a command to be prepared for war in a much shorter period than would be the case were no plans on hand and each responsible officer were required to plan his work, as well as execute it, after war was declared.

It would probably be better, if this problem were given out by the Artillery District Commander to all the Coast Defense Commands in the District. By this means greater uniformity would be obtained throughout the service and probably, through the supervision exercised by the Artillery District Commander, the plans would be made more complete.

Attention is invited to the fact that the preparation of these plans is a task of some magnitude, but how overwhelming the working out of these many details at the outbreak of war would be without such plans and what confusion would result is left to the imagination of the reader.

It is thought not out of place to again suggest, in this connection, that everything possible should be done in time of

peace in the way of organization to facilitate passing to a state of war. The Secretary of War has, for a number of years, been empowered to fix the strength of Coast Artillery companies to fit the armament manned by them. The writer is not informed as to why advantage has not been taken of this authority. It is possibly due to difficulties in the way of quartering companies of different sizes in time of peace in the barracks at present provided, and possibly to a desire to keep the companies of a nearly uniform strength so as to facilitate instruction in infantry work.

The matter of quartering, provisioning, and administering the personnel could, however, doubtless be handled, without great difficulty, as a matter entirely separate and distinct from their artillery work. Our first aim should of course be to perfect ourselves as Coast Artillery and every opportunity possible should be given Coast Artillery officers to devote themselves to Coast Artillery subjects, like the one named at the head of this paper, which is of vital interest to all of us.

A STUDY ON THE USE IN LAND DEFENSE OF HEAVY MOBILE ARTILLERY

1. It is not deemed necessary to present at any length the general arguments for the desirability of introducing heavy transportable cannon into the system of coast defense. These are, briefly:

a. Extension of coast defense to points not now covered.

b. Concentration at threatened points.

c. Greater defensive power at less cost.

d. Attack from places not marked out for the enemy in time of peace.

e. Employment in land defense as well as in sea defense.

f. Strengthening of existing coast defenses by the employment of types of armament which may be used in land operations under certain conditions.

g. Tactical flexibility.

2. A study of the railroad and road facilities already at hand for the employment of such artillery shows, fortunately, very favorable conditions. Our most important strategical sectors are well supplied with railroads and roads. It would be advisable to study these sectors locally, with a view to preparing in peace rail spurs to points of probable attack.

3. It is suggested:

a. That the present tactical units known as Coast Defenses be extended to include the whole coast-line, the limits to be fixed by War Department orders (as is the case at present).

b. That the number of Coast Artillery Districts be increased to include:

North Atlantic District.
South Atlantic District.
Gulf District.
California District.
North Pacific District.
Panama District.
Hawaiian District.
Philippine District.

c. That the rail batteries proposed herein be at the disposal of the district commanders.

4. In the study of the subject of coast defense, the basic considerations are:

a. An attempt to land in force will be made only by a powerful and well-prepared enemy. The preparation against such an attack must be adequate.

b. Sound strategy demands that the enemy be taken at the greatest disadvantage, hence, driven off before landing, attacked in the act of landing, or held to a restricted area.

c. Secure defense against land, water, and air attack of cities, harbors, and fixed fortifications.

Adequate preparation to accomplish these results involves, in addition to the fixed fortifications, mobile artillery powerful enough to cope with modern ship fire, light mobile artillery, machine guns, and small arms.

5. The development of the following mobile armament is proposed.

Rail batteries.—

a. 16-inch mortars of two pieces each.

b. 14-inch guns of two pieces each.

A rail battery should constitute an armed and armored train. Details are given in Appendix "A."

Road batteries.—

a. 11-inch or 12-inch mortar of two pieces each.

The piece would be carried on a separate truck, the carriage on caterpillar wheels, all drawn by a tractor.

b. 6-inch guns of two pieces each.

The guns to be transported in the same manner as mortars.

c. 6-inch howitzer of two pieces each.

The present type of howitzer to be drawn by tractor or heavy motor truck.

d. 3-inch anti-aircraft gun.

To be mounted on a motor truck, a truck to carry one gun with crew and ammunition. Details are given in Appendix "B."

The Ordnance Department contemplates the design of a 16-inch mortar and a 14-inch gun, mounted on and to be fired

from railway cars, and the design of an 11-inch howitzer or mortar to be transported by tractor and fired from a wheel mount. The use of a 12-inch howitzer would simplify ammunition supply, in that projectiles for the present 12-inch mortar could be used.

6. The road batteries should be distributed among the coast defenses by the district commanders. The rail and road batteries in operation would require the protection of infantry and field artillery. For this purpose the Coast Artillery Supports should be specially trained. When these heavy pieces are used for land operations away from the coast they should be at the disposal of the Commander of the field armies.

7. A rail battery, complete, would be a proper command for a major; one or two such batteries with the necessary artillery supports, the command of a lieutenant-colonel; while the whole defense would be commanded by a colonel.

8. Rather as a guiding estimate than as a positive recommendation, the following number and distribution of pieces in the United States are proposed:

District	Coast Defense	16-inch mortar rail batteries	14-inch gun rail batteries	11- or 12-inch mortar road batteries	6-inch howitzer road batteries	6-inch gun road batteries	3-inch anti-aircraft guns
North Atlantic	Portland	2	1	2	2	2	5
	Portsmouth	–	–	1	1	1	3
	Boston	4	2	2	2	2	8
	New Bedford	–	–	1	1	1	3
	Narragansett	–	–	1	1	1	6
	LongIslandSound	4	2	2	2	2	5
	E. New York	–	–	1	1	1	3
	S. New York	–	–	1	1	1	3
	Sandy Hook	–	–	2	2	2	3
	Total pieces	20	10.	26	26	26	39
	Delaware	2	1	1	1	1	4
	Baltimore	–	–	1	1	1	5
	Potomac	–	–	1	1	1	3
	Chesapeake	–	–	1	1	1	3

District	Coast Defense	16-inch mortar rail batteries	14-inch gun rail batteries	11- or 12-inch mortar road batteries	6-inch howitzer road batteries	6-inch gun road batteries	3-inch anti-aircraft guns
South Atlantic	Cape Fear	4	2	1	1	1	2
	Charleston	–	–	1	1	1	3
	Savannah	–	–	1	1	1	3
	Total pieces	12	6	14	14	14	23
Gulf	Key West	2	1	1	1	1	3
	Tampa	–	–	1	1	1	3
	Pensacola	–	–	1	1	1	4
	Mobile	2	1	1	1	1	3
	New Orleans	–	–	1	1	1	3
	Galveston	–	–	1	1	1	4
	Total pieces	8	4	12	12	12	20
California	San Diego	4	2	2	2	2	2
	Los Angeles	–	–	2	2	2	2
	San Francisco	–	–	4	4	4	8
	Total pieces	8	4	16	16	16	13
North Pacific	Columbia	4	2	2	2	2	3
	Puget Sound	–	–	6	6	6	6
	Total pieces	8	4	16	16	15	9
	Aggregate number of pieces	56	28	84	84	84	104

9. The system of finding ranges by means of a horizontal base can be used with the different batteries proposed. This system should be supplemented by coincidence range finders.

10. The importance of adequate defense should be emphasized and, also, it should be pointed out that this entire project, which it is believed will afford such a defense, will, as shown in the estimates given in the appendices, cost, including the ammunition, only as much as two battleships.

APPENDIX "A"

Rail Batteries

The mortars and guns are to be mounted on and fired from standard-gauge railroad cars. The mounting must be

of such height as to allow the cars to be taken through tunnels. Special construction will be required only for the cars carrying the mortars and guns. The ammunition cars should have a carrying capacity of at least 50 tons and be fitted with racks for conveniently handling projectiles and powder cases. It is assumed that the weights of the charges, powder and projectile, for the mortars and the guns are approximately 2000 lbs., and that 100 rounds would be carried for each gun and 300 rounds for each mortar.

I. MORTAR BATTERY

Composition

		No. of cars
1.	Cars for 2 16-inch mortars	2
2.	Cars for ammunition, 600 rounds, weight 600 tons, 50 rounds per car	12
3.	Car for tools and appliances for handling mortars, fire control instruments, etc.	1
4.	Cars for track material, 1 mile	7
5.	Car for 10 machine guns and 1 anti-aircraft gun, and ammunition	1
6.	Car for captive balloon equipment, radio equipment, and gas motor power plant	1
7.	Car to carry 2 60-inch searchlight trucks	1
8.	Cars for manning party, 10 officers and 250 enlisted men	6
9.	Wrecking car	1
10.	Steam shovel	1
		33

Locomotives, 2 (1 large, 1 small)

Cost

While this estimate is merely an approximation, it is believed that it is higher than the actual cost.

1 16-inch mortar	$15,000
1 carriage	10,000
1 car	15,000
Tools, appliances, instruments, etc.	5,000
	$45,000

2 16-inch mortars and cars	$90,000
22 cars for material	44,000
6 cars for quarters	30,000
1 wrecking car	4,000
1 steam shovel	6,000
Ammunition, 16-inch	180,000
10 machine guns and 1 anti-aircraft gun, and ammunition	15,000

Track material, 1 mile	10,000
Searchlights	7,000
Radio equipment	5,000
Power plant	10,000
Balloon equipment	10,000
2 locomotives (1, $25,000; 1, $15,000)	40,000
Cost per battery, complete	$451,000
Cost of 28 batteries, complete	$12,628,000

II. GUN BATTERY

Composition

		No. of cars
1.	Cars for 2 14-inch guns	2
2.	Cars for ammunition	4
3.	Car for tools and appliances for handling guns, fire control instruments, etc.	1
4.	Cars for track material, 1 mile	7
5.	Car for 10 machine guns, 1 anti-aircraft gun, and ammunition	1
6.	Car to carry 2 60-inch searchlight trucks	1
7.	Car for captive balloon equipment, radio equipment, and gas motor power plant	1
8.	Cars for manning party, 10 officers and 250 enlisted men	6
9.	Wrecking car	1
10.	Steam shovel	1
		25

Locomotives, 2 (1 large and 1 small)

Cost

1 14-inch gun	$ 60,000
1 carriage	25,000
1 car	20,000
Tools, appliances, instruments, etc.	5,000
	$110,000

2 14-inch guns and cars	$220,000
14 cars for material	28,000
6 cars for quarters	30,000
1 wrecking car	4,000
1 steam shovel	6,000
Ammunition, 14-inch	90,000
10 machine guns, 1 anti-aircraft gun, and ammunition	15,000
Track material, 1 mile	10,000
Searchlights	7,000
Radio equipment	5,000
Power plant	10,000
Balloon equipment	10,000
2 locomotives, (1, $25,000; 1, $15,000)	40,000
Cost per battery, complete	$475,000

Cost of 14 batteries, complete	$6,650,000
Cost of 28 16-inch mortar batteries and 14 14-inch gun batteries	$19,278,000

This amount is less than the probable cost of one of the proposed type of battleships. It will be noted that the estimate includes the cost of ammunition, which amounts to $6,300,000.

APPENDIX "B"

Road Batteries

I. Two 11-inch or 12-inch mortars

Composition

For transportation the mortar would be removed from the carriage from which it is fired, and carried on a separate pair of wheels. The carriage proper and the carriage for transporting the mortar would be drawn by a powerful tractor.

Ammunition, 600 rounds per mortar.

Estimate of Weights

	tons
1 mortar	10
1 carriage	15
1 carriage for transporting mortar	4
1 tractor	7
Ammunition to accompany battery:	
140 rounds (projectile, 700 lbs.; powder, 100 lbs.)	56

This ammunition to be hauled on eight trailers, four trailers being drawn by one tractor.

The tractor should carry an electric power plant, which would furnish power for driving electric motors on each trailer. Thus each trailer would have motor power, and the ability of the section to move over difficult roads would be assured.

Cost

1 11-inch mortar	$11,000	
1 carriage	10,000	
1 carriage for transporting mortar	4,000	
1 tractor	8,000	
	$33,000	
2 11-inch mortars		$66,000
Ammunition section:		
1 tractor	$8,000	
4 trailers at $4,000	16,000	
	$24,000	

2 ammunition sections		$ 48,000
Ammunition, 1200 rounds		150,000
Total		$264,000
Cost of 42 11-inch mortar batteries		$11,088,000

II. TWO 6-INCH GUNS

Cost

1 6-inch gun	$9,000	
1 carriage	8,000	
1 carriage for transporting gun	4,000	
1 tractor	8,000	
	$29,000	
2 6-inch guns		$58,000

Ammunition: 200 rounds per gun.

Projectile—weight, 100 lbs.; cost, $20.
Powder—weight, 40 lbs.; cost, $20.
Total weight of ammunition, 28 tons.

This ammunition can be carried on one ammunition section described above for 11-inch mortar battery.

1 ammunition section		24,000
Ammunition, 400 rounds		16,000
Total		$98,000
Cost of 42 6-inch gun batteries		$4,116,000

III. TWO 6-INCH HOWITZERS

Cost

1 6-inch howitzer and carriage	$10,000	
1 tractor	5,000	
	$15,000	
2 6-inch howitzers		30,000
2 ammunition sections as described for 6-inch gun		48,000
Ammunition, 400 rounds per gun		26,000
		$104,000
Cost of 42 6-inch howitzer batteries		$4,368,000

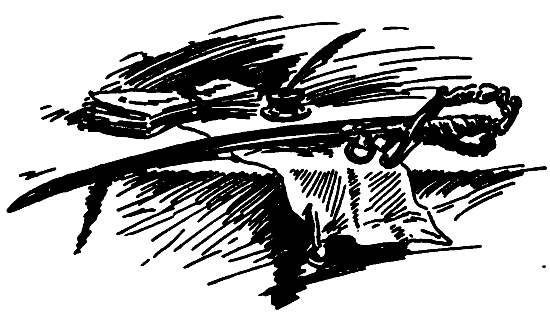
IV. 3-INCH ANTI-AIRCRAFT GUN

This gun is to be mounted on and fired from a motor truck.

Cost

1 3-inch gun and mount	$3,000
1 motor truck	4,000

Ammunition, 500 rounds	6,000	
3 3-ton motor trucks at $4,000	12,000	
	$25,000	
Cost of 104 anti-aircraft gun batteries		$2,600,000
Aggregate cost of road batteries, complete		$22,172,000
Aggregate cost of rail batteries, complete		19,278,000
Total estimated cost of project described above, complete		$41,450,000
Cost of ammunition: Rail batteries		$6,300,000
Road batteries		9,024,000
Total		$15,324,000



THE PRINCIPLES INVOLVED IN THE MINE DEFENSE OF HARBORS

By First Lieutenant CARL A. LOHR, Coast Artillery Corps

This subject may be approached by first trying to understand a single mine as now used, and then enlarging upon its usefulness and adaptability to harbor defense.

A submarine mine may be defined as a case containing a charge of explosive with firing device, moored at or under the surface of the water for the purpose of disabling a hostile ship. A torpedo is a means for conveying an explosive charge through the water to the under-water surface of a hostile ship and there exploding it. The mine defense of harbors in its largest sense takes in all means of attack against the under-water hull of hostile ships.

Much has been written about the history of the mine and it does not appear necessary to trace its development, except in a way to show its importance in future wars.

Ever since Bushnell molested the British ships during our Revolutionary War, the mine has been considered a possible weapon by the various navies of the world. But, not until our Civil War was it seriously considered a factor worthy of mention. During that war mines were much used at the entrance of the Confederate harbors to keep out Federal gunboats; and, while twenty-five ships were destroyed and much done toward the development of the mine, still it must be admitted that the new mode of warfare did not make the impression it should have made. It did not cause great fear in the minds of the American admirals. Even as late as the Spanish American War, Admiral Dewey entered Manila Bay with the same defiant "damn the torpedoes" air as in the case of Farragut at Mobile.

A study of the Russo-Japanese war, however, reveals the fact that the mine was much feared by both belligerents. This is not to be wondered at. The original mechanical gunpowder mine which was often as dangerous to friend as to foe, had, in

the meantime, been transformed into an electrically controlled combination observation and contact high explosive mine.

Another cause for mines not having formerly been feared, is found in the fact that the old ships were small and could be built in a short time and at a relatively small cost, while the battleships and cruisers used in the Russo-Japanese War, if destroyed, could not be replaced, both requiring more time and money to build than was available in war; so neither nation dared sacrifice its ships as in days of old.

As ships continue to increase in size and as the mine continues to be perfected, the more formidable a weapon does it become. To show how serious a consideration the mine is becoming, it is sufficient to point out that while only a few years ago the navy did nothing in the way of mining, yet within the last six years there has been considerable awakening to the realization of the importance of the mine in future wars. Indeed, all of the great powers are giving serious attention to this most dangerous weapon, and the mine is being used not only in harbors but also in the tactics of fleets.

It therefore appears that every effort should be put forth to effectively mine even the most difficult harbors. For, even if typical lines of mines cannot be kept down at the entrances of some harbors, mines of some description should be planted in order that it may be generally known that there are mines for every harbor, advantage being thereby taken of the moral effect which the knowledge of existing mines is sure to cause during future operations.

As stated above, a modern high explosive has replaced the gunpowder formerly used, greatly reducing the weight for the same explosive effect and giving to the mine when loaded a greater buoyancy, much needed in many harbors; and, while it is thought that there is now available an explosive which may be set off under the most adverse circumstances, it is possible to develop a suitable charge with still greater explosive effect. However, it is not profitable to discuss the relative power of high explosives, because there is little data at hand as to the exact effect of subaqueous explosions, and because there are many other qualities which a high explosive must possess, in addition to the explosive power, to make it suitable for underwater use.

For the purposes of this article, let it be considered that there has been adopted the best known explosive for the mine, and let it also be assumed that the electric combination con-

tact and observation system of firing the mine is the best known at present. It should not be understood, however, that complete satisfaction is felt with the explosive and the means for setting it off in the mine. Much more extensive experiments should be made than have been, in order that we may further develop a system, which, for lack of recent experimental data, we must for the present accept as being the best that can be obtained. We should endeavor to discover every defect possible by actually firing mines against the hulls of ships representing the double-bottom structure, of the very latest type, under all conditions of sea, weather, and tide; and we should extensively experiment in all manner of known means for disabling our mine fields, to the end that there may be no question in the mind of anyone as to the excellence of our entire system. For, while there is no question as to its theoretical value today, so little recent practical experimental work has been done that, even with our acknowledged excellent system, we must always turn back to General Abbott's work for practical experimental data. There is no question as to the value of the experimental work performed to date, but the amount of available data obtained within recent years is so small as to be insufficient for approaching the correct solution of so vital a problem as the mine defense of our harbors.

How do we know just how big a hole one hundred pounds of our high explosive will blow in the bottom of the most modern ship without trying it? How do we know whether our corrugated case will stand the shock of discharge of adjacent mines without trying it? How do we know the exact effect of currents upon our elongated case without systematically recording carefully observed data? How do we know whether to use an elongated case or a sphere without actually measuring and recording resistances of these cases? How do we know whether to use one or more anchors without trying them? These are some of the most simple questions which come up whenever a project is worked out, and without an exact knowledge of what will happen the project is incomplete or fails entirely. It therefore appears that while the discussion at hand must be chiefly hypothetical it must be taken for what it is worth only in outlining a means for working out the mine defense of our harbors.

As long as we continue to make progress we may hope to obtain a still lighter explosive with a lighter means for setting it off. Buoyancy is the great desirable factor in submarine

mine work. This is especially true in those harbors in which there are strong currents.

Many officers desire to increase the weight of charge in the mine. But, when it is considered that the heavier the charge the less the buoyancy, and, therefore, the greater the effect of currents upon our mines in changing their location and submergence, the wisdom of this increase in weight of charge should be questioned and every effort made to keep the buoyancy as great as possible. It is generally accepted that the destructive radius of a mine can only be proportionate to the square-root of the charge. If 14 feet is the destructive radius of 100 pounds of our explosive, then doubling this amount will only increase this radius to 20 feet, a gain of 6

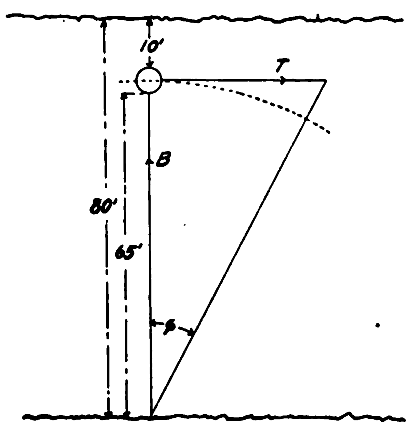


FIG. 1. 1910

feet but a loss in buoyancy of 100 pounds. If the available buoyancy of our No. 32 mine case is 300 pounds, 500 pounds for the 38 case, and 1100 pounds for the 48 case, the absurdity of trying to use a 32 case in a strong tide-way can be seen without calculation. The Nos. 38 and 48 cases would then have left respectively only 300 and 900 pounds of reserve bouyancy after being loaded with 200 pounds of explosive. The following calculation will further show the value of buoyancy.

Let the depth of water be 80 feet, and the desired submergence 10 feet. The length of mooring rope will therefore be 65 feet. Taking General Abbot's formula, we find that for a 65-foot mooring rope 4 knots of tide gives 30 feet of depression for the No. 32 mine case. Assuming that General Abbot used a mooring and raising rope on his No. 32 case, the reserve

buoyancy without charge is equal to the displacement minus the weight of case and ropes, or $635-308-40=287$ pounds reserve buoyancy.

Let φ = the angle made by the mooring rope with the vertical;

T = the horizontal component force of the tide in pounds of pull;

B = the vertical component force of the buoyancy of the mine case in pounds of pull.

Then $$\tan\varphi=\frac{T}{B}$$

Again, taking General Abbot's formula we find that the angular sway of a 65-foot mooring rope in a 4-knot tide is 55 degrees.

Therefore $T=287 \tan 55$
$=410$ lbs. pull.

The pull due to the force of the tide is also directly proportional to the area of the surface exposed. For the No. 32 case this is πR^2, or 805 sq. in., and for the No. 50 case it is πR^2 plus $2\,Rh$, or 2425 sq. in. The No. 50 case therefore exposes 3 times as much surface to the action of the tide as does the No. 32, and, therefore the horizontal pull due to tide will be 3 times as great. The pull of a 4-knot tide on a No. 50 case is therefore $410\times 3=1230$ lbs. pull.

For the sake of true comparison we must compare loaded mines rather than empty ones, and for the sake of a supposition let us first take our normal charge of 100 lbs. We must also assume a certain added pull against the buoyancy due to the single conductor cable, raising rope and mooring rope. For the No. 32 mine, B then becomes $635-308-120-100=107$ lbs. buoyancy; and for the No. 50 mine case, B becomes $2323-777-120-100=1326$ lbs. buoyancy.

$$\text{Tan}\ \varphi_{32}=\frac{410}{107} \qquad \varphi_{32}=75.4 \text{ degrees}$$

$$\text{Tan}\ \varphi_{50}=\frac{1230}{1326} \qquad \varphi_{50}=42.8 \text{ degrees}$$

Now, the actual vertical height of the mine above the bottom in each case will equal $65 \cos\varphi$. For 75.4 degrees this becomes equal to 16.5 feet and for 42.8 degrees this becomes 47.7 feet. $75-16.5=58.5$ feet, submergence; $75-47.7=27.3$ feet, submergence; which at once shows the theoretical advisability of great buoyancy.

Roughly speaking, the buoyancy of a mine varies directly as the cube of the sphere of the volume represented, and the resistance of the case as the square of the surface opposed to the current. It is therefore necessary to increase the size of our case to such an extent that the buoyancy will be sufficient to keep the mine at the desired depth. This in turn will make it necessary to increase the size of our anchor and mooring rope and make the adoption of other means for fastening the case to mooring rope a necessity. It is often stated that this is a problem that cannot be solved. This is not true. If the Light House establishment can securely moor buoys of the size now used in all harbors, why can we not securely moor mines as may be necessary? It can be done. It has been said that our whole mine system will only cost half as much as a single battleship. Suppose the cost is twice that of a battleship, or much more for that matter, what difference does it make? When it is considered that after our Navy has been defeated and most of our batteries silenced, our mine defense must then keep the victorious fleet from entering our harbors and hence no nominal sum is too large for an adequate system.

There are today strong advocates for the use of the torpedo. Many of these base their arguments on the supposition that mines cannot be kept down in many of our harbors. They argue that a torpedo defense system will cost less than the development of a mine system as above outlined. But, even if it should the torpedoes must be fired in exactly the same way as are the guns, and the torpedo stations can be silenced and put out of action in the same way as the batteries. The torpedo is an excellent weapon, but a mine well placed cannot miss a ship which touches it while the probability of hitting with a torpedo is far less than with a great gun projectile. There is no question as to the necessity of torpedoes for harbor defense, but, we should first of all try every known means to so place our mine that it will stay where we want it, and be sure of action under the most adverse circumstances as it now is under the best. The effective range of the torpedo is only about 5000 yards and the mechanism to be adjusted in each is so much more complicated and difficult to keep in order, as compared with anything in our present mine defense, that the chance of doing injury to battleships is far less in the case of the torpedo than in the case of the mine.

Our mine, as now made up, holds a charge of high explosive with electric means for setting it off. We have agreed to

accept both the explosive and the means for setting it off because we know of no way to improve either. The mine case is at present moored to an anchor by means of shackles, sister hooks, mooring rope and a mine dome carrying the bails and bail ring, the mooring rope being shackled to the bail ring, and the turkshead being inserted and clamped into the dome. The weakest part of the mine and its mooring is right at this point. Either the conductor is broken and chewed off just below the turkshead or the mooring rope is broken off. To overcome the latter, chains have been tried; but the links crystalize and soon break. Experiments should be made using a mooring swivel and wrapping the conductor armor with strong wire from the turkshead collar down to and below the bail ring, and securely lashing or clamping the single conductor to the bail. The removal of this the greatest weakness in keeping our mine down must be overcome experimentally rather than theoretically. Captain Bunker's scheme of using 2 anchors as described in the March-April, 1914, JOURNAL U. S. ARTILLERY would without doubt keep the mine more nearly at the half way point between the two anchors, but this scheme is not entirely complete without using 4 anchors, and when using only 2 there will be many times when the strain is off one mooring rope and entirely on the other. If either mooring rope is to be subjected to the same strain there will be the same breaking of rope in time, and therefore is it thought that a mooring swivel must be used on the mooring rope and the conductor must be sufficiently strengthened to take the turning strain of the mine, unless a swivel for the conductor can also be devised and be properly insulated and kept dry. In any event all these schemes should be tried out in order that strong moorings with strong conductors may be obtained.

Before proceeding further the question of submergence should be touched upon. There are advocates for 5 feet, 10 feet, 15 feet, etc., but few consider the difficulties of keeping to any prescribed submergence. In most harbors the tide rises and falls through a distance of at least 5 feet. If 5 feet below mean low water is taken the mine will then be 10 feet below mean high water. In many of our harbors the rise and fall of the tide is more than 5 feet. When we consider the effect of the horizontal component of the tide to pull the mine under still further it is not difficult to get nearly any submergence desired. We have already shown that a No. 50 case will be kept 27.3 feet under water with a 65-foot mooring rope

in 80 feet of water by a 4-knot tide. This however allows 10 feet for submergence at 0 tide. If only 5 feet are allowed this becomes 22.3 feet. All modern battleships draw from 24 to 30 feet and for that reason we may conclude that for a 4-knot tide and 10 feet change in tide, a No. 50 case has sufficient buoyancy when containing a 100-pound charge, if moored just under the surface at low water, to be sure of coming in contact with the bottom of a ship which has laid its course over the mine.

The question of submergence is a local one, and should unquestionably be decided by the rise and fall and the horizontal component of the tide at the place. We should not be too particular about just the spot we desire to injure when exploding a charge of high explosive under or along side the bottom of a battleship. But we should be careful to get that submergence which will make sure that every battleship which crosses the mine will touch it. If there is little tide a submergence of 10 feet at low tide is not too much but if the tide is appreciable its effect should be carefully figured as outlined above.

The chief reason for submergence is to hide the mine, so that it cannot be easily located by boats or aerial craft. The advocates for large explosive charges undoubtedly have in mind to entirely destroy a battleship with one charge. Modern ships are built structurally so strong with double bottoms and water-tight bulkheads that a single charge will not always sink a ship. It would of course be absurd to argue that a sufficiently large charge can not be planted to sink a ship, and if a perfectly feasible scheme can be worked out whereby the submergence of mines can be controlled within narrower limits, either by using double moorings, or by increasing the buoyancy, or by any other means, there will then be ample time to consider the use of larger charges.

But why lay so much stress upon sinking each battleship? If we are to use more than one mine in all probability another will be exploded under this same ship if the first one does not do sufficient damage.

Consideration should be given to what will happen on board ship when each mine is exploded. Should a charge be set off while the case touches some part of the bottom of the ship, the under-water hull will be punctured at that point. From one to four compartments will be filled, depending upon the exact location of the explosion. The most favorable loca-

tion is at the junction of a longitudinal and athwartship bulkhead. In this case four compartments will fill with water. The ship will immediately be listed and in order to maintain an even keel the corresponding opposite compartment, or compartments, must be filled. The ship's draft will thus be increased and confusion caused on board. The ship's course and speed will then unquestionably be changed. This in turn will cause confusion to the ships following. If all should continue to enter the harbor and the first ship still hold her own it will be necessary to explode another mine under her, and finally cause her to settle sufficiently to beach her. The second ship will then try to get through, and so on, each in turn causing greater confusion to the remaining ships of the fleet, as mines are exploded under them. This, no doubt, appears to be a much easier game on paper than it really would be. But why should it be a difficult task to disable ship after ship in the manner just stated if each mine is rightly placed and enough mines are laid?

We have thus far generally considered the importance and characteristics of the mine to be used in the defense of our harbors, but no consideration has been given to the relation of mines to themselves, to the shore batteries, or to the torpedoes to be used.

It is generally conceded that the practice of placing mines in lines is good; these lines may be straight or curved, in order that greatest advantage may be taken to simplify the laying; but, they must be laid in some sort of systematic manner in order that the distances between mines be not too great and in order that they may be properly charted for firing. From what has just been said it is concluded that we must have enough lines and the mines be so well placed in these lines that we may actually fire a reasonable number and still keep our system in condition to resist further attack.

Let us again refer to the under-water structure of a modern battleship. The beam is about 95 feet and each year in time adds about a foot to the beam, so that we are reasonably sure of being on the safe side if we assume that the smallest space required by a battleship in passing a line of mines is 95 feet. Except for the round of the bilge the amidship section of a battleship is full beam width even at her lowest draft, so that it is again reasonably safe to assume that the ship will touch the mine if the latter is anywhere in the rectangle 95 feet by ship's draft, say 28 feet.

In order to make it impossible for any battleship to pass any line of mines without touching one of them they must be planted not further than 95 feet apart and have a maximum submergence of not more than 28 feet at highest high water and in the strongest running tide. All mines should be planted within these limits in order that there will be positive assurance of contact between the ship's hull and some mine of each line.

The lines may be run at right angles, or nearly so, to the channel. It is only necessary to decide how many lines are required and where these lines shall be placed. This, again, is a local problem; but the following will hold for all harbors: The mines located within the harbor are more easily maintained than those outside. The narrower the channel at points where lines are located the smaller is the number of mines required. The narrower the channel the greater is the tide. The latter disadvantage may entirely offset the former advantage and may make it necessary to locate the field out to such a distance that both the number of mines and the lines be greatly increased. The former may be necessary because the field cannot be easily repaired and the latter to insure effective lines, should certain mines become inoperative.

In discussing the number and length of lines of mines required, it should be understood that our mines must be laid for a definite purpose, and should not be used except for the purpose laid. So long as the guns of the harbor fortifications can keep the battleships off beyond effective battleship range there is no use for mines. But, when the batteries can no longer prevent the fleet from entering to effective range then there is need for a barrier. Mines are used in naval warfare in exactly the same way as barriers and obstacles are used in field warfare.

Due to the fact that the mines must become the last means of defense for a harbor they should be made effective and the batteries located with reference to them. It should be the purpose of the guns to keep all of the enemy's forces out beyond the mine field and thus insure the entire protection of the mines against possible injury. This may be considered an extreme view. But, when consideration is given to the fact that in many cases the mines may have to be laid at such a distance from the shore batteries that their protection can only be accomplished by guns of the greatest caliber, the problem might as well be solved by using the necessary arma-

ment first as last. It is generally conceded that 3-inch guns are almost useless in the defense of mine fields and that not less than 5-inch and 6-inch guns should be used. If the mine field can be entirely defended by the use of 5-inch and 6-inch guns it should be so defended by all means, because these guns can be fired at a rapid rate, but no harbor is known where the 3-inch guns will prove to be sufficient for the entire protection of the mine field.

Our text-books tell us that the mines should be placed just beyond the inner zone of mortar fire and within the most effective range of our major caliber batteries. This is thought to be sound reasoning, but should the batteries be placed after the location of the mine field has been established it appears advisable to place all batteries as stated above for the protection of the mine field.

The location of torpedo tubes for firing torpedoes bears much the same relation with reference to the position of the mines as do the batteries. They should be located out at the entrance to the harbor in order that advantage may be taken of their short range, and in order that they may be of use at as early a time as possible in harbors difficult to mine. In selecting the location of the tubes a protected cove should be selected, so that the torpedoes may be properly launched and accurately started on their runs under as easy conditions as possible. The torpedo stations must be adequately protected by the heaviest armament, for they are sure to draw the fire of the opposing fleet, and, for that reason should also be well concealed.

Torpedoboats and destroyers possess no advantage for use in connection with coast fortifications. They are useful, but are so easily visible and so likely to be singled out by the enemy's destroyers and larger ships that their chances of assistance to coast fortifications, unless with the fleet, are considered small. Submarines are capable of rendering great assistance to coast forts and may be considered necessary. Since they can operate so well without being discovered and have every facility for discharging torpedoes, they should be procured for the defense of our most difficult harbors.

Immediate steps should be taken for the procurement of torpedoes and for both the procurement and installation of tubes in all harbors in which it is not definitely known that our mine defense can be made efficient. Too little importance has been attached to the use of torpedoes for such harbors and

little time should be lost in their installation, lest it be too late. The installation of torpedo equipment need be no excuse for not exerting every known means to still make the mines effective for even the most difficult harbors, since, as stated above, the mines are far more reliable when securely and effectively placed. Here, attention should be invited to the fact that nothing has been done to furnish our harbors with torpedoes, which the Navy has proven to be effective, and again, as in the case of much mine work, we find inadequate data from recent experimental work.

We have touched upon the relation of the fixed means of defense to the mine field but have not entirely established the relation of the lines of mines to each other. We have decided to place our mines not more than 95 feet apart and to leave the question of submergence, a variable one, in order that one mine will always be in every 95 by 28 foot rectangle along each line, but we have not decided upon the number of lines or the length of them. Again, a local aspect presents itself, and in each case local conditions must decide. In general the number of lines should not be less than three and in the most important harbors more lines should be used, depending upon the width of the channel; for, the wider the channel the less chance there is for confusion among the enemy's ships when mines are exploded. The lines should be sufficiently far apart so that a single ship will only foul one mine at a time as it passes in and so that it will straighten out on its course before coming to the next mine. For this reason the greatest tactical diameter of the largest floating battleship with standard helm should be considered. This is not less than 750 yards.

The question also arises as to length of lines. In the consideration of this point we must decide whether mines would be used against vessels of lighter draft than battleships. Heretofore in this discussion we have assumed that the lightest draft ship against which a mine would be used is one drawing 28 feet. This assumption was made because the question of submergence is a difficult one and still easily solved if the range of submergence can be controlled within 28 feet. There is strategy in mining just as surely as there is in other modes of warfare and the question which rises in placing and firing mines must be given the same strategical consideration. The determination as to whether a particular mine should be used against a cruiser or destroyer is a strategical problem, and must be solved partly in advance of operations against the harbor

fortifications, because if it is decided that mines may be used against light draft ships all lines must be longer. In considering this question we should not, however, forget the enemy's position and what he will do. He would like nothing better than to have us disable our mine fields against his torpedo-boats, destroyers, and cruisers. These smaller craft can be replaced and it is the enemy's game to have them destroyed if it will in any way help him. It therefore does not appear that we should use our mines against ships of light draft but should expect our armament to completely disable all of the enemy's light draft ships. For this reason mines should not be placed in water the depth of which is less than 28 feet at high tide, and our lines of mines should be limited to lesser depths.

In the above discussion no mention has been made of any system for firing our mines. Little has been said about the mine being swept out of its charted position by the tide. The surest means of knowing when a mine has been struck is to make the mine signal that fact to the shore station. During our mine practices misses have been made through over-anxiety on the part of the plotter, casemate electrician, telephone operator, or some other member of the fire control section when firing by observation. If this happens during practice we should expect the same and greater inaccuracies during action. While it is thought that every attempt should be made to secure efficiency in observation firing, so that it may be used, still all considerations point to the fact that the mine should be fired only upon signal to the casemate that the particular mine has been struck. Should the mine observation stations remain intact the identity of the mine may be checked and the mine commander can then order the mine fired or not as he may desire. Times would undoubtedly arise when the particular mine should not be fired. This then resolves itself into what may be known as delayed contact firing.

Another consideration which should not be left untouched is that channels must be designated for the passage of friendly ships. Our Navy must be free to move in and out of our harbors. It may be necessary to move supplies in and out, etc. In every case channels sufficiently wide must be left. These may be straight or otherwise; it matters not so long as we have pilots who can take our ships in and out. But, in leaving the necessary channels we must be prepared to close them upon the approach of the hostile fleet. This may be

accomplished in either of two ways. Continuous uninterrupted lines may be planted with explosive links in the mooring ropes of those mines in the channel or the mines may be planted in the face of the hostile ships in the blank spaces of the original lines. A convenient means would be to use multiple cable to the nearest line, and there use a grand junction box from which 3-core conductors are taken, each 3-core conductor leading to a 4-core distribution box. The channel in that case would be 380 feet wide.

The position finding stations, casemate, storehouse, and wharf should all be concealed from direct view. Special precautions should be taken to hide the casemate, which should be difficult to find even after the enemy has landed; in this way the system may be kept effective the longest possible time and be the last of the defense to give way.

The above discussion is longer than it should have been, but it is felt that a most complete study should be made of all phases which might in any way bear upon the mine defense before any attempt is made to even outline a project, and that after outlining it a most complete understanding must be had of all conditions by as much experimental work as necessary. For these reasons many things have been touched upon to show that they must not be overlooked.

Much of the above discussion has been of a more or less rambling nature and for that reason it is well to summarize and more definitely lay down the principles to be observed in the defense of harbors, which are as follows:

1. The mine offers the most effective means of exploding a charge of high explosive against the under-water bottom of a ship.

2. The mere knowledge that mines have been laid has a great moral effect upon the opposing fleet.

3. The mine must be capable of fatally injuring the under-water bottom of the latest battleship.

4. Experimental data is necessary in order that the project may be completely worked out with reference to both local and general considerations.

5. The weight of the charge should not be so great that the buoyancy of the mine is sacrificed.

6. Buoyancy is a very important characteristic of the mine and should be sufficiently great to insure an effective submergence at all times.

7. Anchors, mooring ropes, cables, and all mine attachments must be sufficiently strong and flexible to take the strain of all forces acting against them.

8. Torpedoes are auxiliary to mines, and should be used in conjunction with the mine defense of all harbors where there is any question as to the positive working of the mines.

9. No ship should be able to enter a harbor against our will without touching several mines while entering, or without having as many torpedoes exploded under her.

10. Definite submergence should not be insisted upon, except as may be necessary to hide the mine and insure its touching the under-water bottom of every ship having a draft of 28 feet.

11. Mines should be laid in lines having a general direction perpendicular to the main channel.

12. The mine defense must be properly protected, if necessary, by all of the heaviest armament. The mine field should therefore be within the most effective range of the major caliber armament and beyond the inner zone of mortar fire.

13. Torpedo tubes should be located at the very entrance to the harbor in order that they may be of use as soon as possible.

14. Torpedo stations must be adequately protected.

15. Submarines are necessary for defense and should be provided for our most difficult harbors.

16. The number of lines of mines should not be less than three, and these lines should be 750 yards apart.

17. Mines need not be planted in less than 28 feet of water unless special exceptional conditions exist.

18. The project must be easy to handle and above all things, sure of disabling every hostile ship drawing 28 feet of water.

19. Delayed contact firing, checked by observation firing should be used for firing mines.

20. An open channel must be kept for friendly ships until the hostile fleet is about to make its attack, and then this channel must be securely closed.

21. All shore elements of the mine defense should be well concealed. The casemate must be particularly well concealed and so strongly inclosed that it will be the last of the fortifications to be destroyed.

THE S. S. "NOORDAM" AND A MINE

By Captain ARCHIBALD H. SUNDERLAND, Coast Artillery Corps

Most coast artillery officers are quite familiar with the effects of a small submarine mine upon a light raft made of keg buoys, and every one is familiar with what are generally the ultimate results of a ship's contact with a mine or torpedo. At this time there are almost daily reports of the sinking of vessels by mines or torpedoes, but there is very little information as to what are the actual local effects on the vessels. The work of a mine is generally so effective that the vessel sinks within a very few minutes, without any one's knowing what actually happened to the structure of the ship.

Through the courtsey of the manager of the Holland-American Line, I was permitted to examine the S. S. *Noordam* after she was in dry dock in Rotterdam, Holland, for repairs necessitated by her contact with a submarine mine in the English Channel.

The S. S. *Noordam* is a twin screw Holland-American Liner of 12,531 tons register. She was on a trip from New York to Rotterdam, when, at about noon on October 17, 1914, in lat. 51°+N. long. 2°+ E., a very severe shock was felt by all on board. One passenger is reported as having seen a column of water shoot up near the stern as high as the masts; another passenger told me that he was sitting in the Captain's cabin, near the bridge, and the shock shattered a mirror fastened to the wall of the cabin. No one was hurt and it is reported that the only person inconvenienced was one who was bathing; the shock split the bath tub and let out all the water. A marble mantel with rather elaborate details in the smoking room, was more or less damaged. After the accident, the ship proceeded to Rotterdam (about 80 miles) under her own steam.

The damage of consequence was all at the stern. The figure indicates roughly the location and extent of the damage. (The figure is not from a drawing of the *Noordam*, but will suffice to show what happened.) The rudder was hinged at

five places similar to the three shown at *A*, *B*, and *C*. Four of these hinge-pins, each about five inches in diameter, were sheared off. The rudder was almost entirely torn away from the supporting beam along the line *DE*, at least a square foot of cast iron being sheared. The rudder was left supported only by a very weak attachment at *D* and by the hinge *C*.

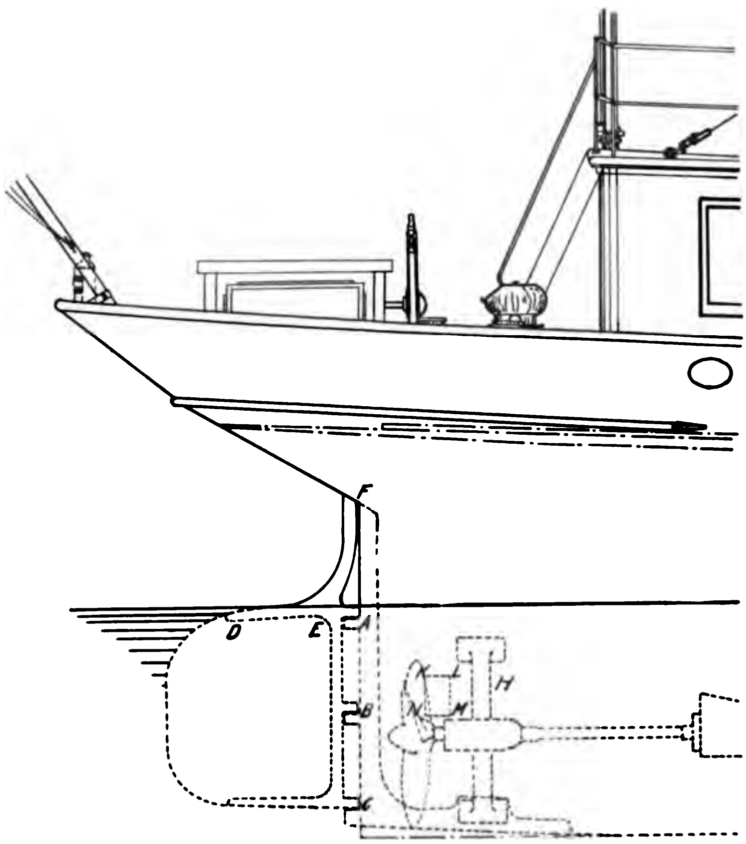


FIG. 1. 1811

The hole at *F*, through which the rudder post projects, was greatly enlarged and deformed.

Neither propeller was damaged to any visible degree, but the cast iron braces, *H*, of both the port and starboard shafts, were cracked. These braces were of cast-iron and about eight inches square. On the port side, rivets were pulled out of the plates that formed a sheathing for the shaft just forward of the propeller. Wire rope was found twisted up in both propellers.

On the port side and in a position about as indicated by the rectangle *KLMN* a plate about 2½ x 4 ft. was stove in, being sheared along its top and forward edges. This plate was nearly an inch thick. This opening, which was about 14 ft. below the water line, allowed a very small compartment to be flooded, but did no material damage.

The overhang of the stern extends fifteen or twenty feet beyond the rudder post, but there was no damage done to it and no evidence at all of its having been struck by a column of water. From this and the wire rope in the propellers, it appeared that possibly the mooring rope of a mine that had broken away from its anchor, became entangled in the port propeller and that this drew the mine towards the ship and that the mine exploded before it came in actual contact with any part of the ship or even before it got under the overhang. The rush of water from an explosion in such a position would stave in the plate in the side, and, by bearing on the large surface of the rudder, would carry away the hinges. Such a rush of water, by causing the whole lower part of the stern to yield, would crack the shaft supports at *H*.

Plotting the position of the *Noordam* at the time of the accident, it is found that she was almost in the geometrical center of the rectangle designated by the English Admiralty as dangerous waters. There seems to be considerable mystery as to why she was in such a position. Possibly the mine was not adrift, but was moored where it was originally planted—if so, I cannot account for the peculiar results of its explosion.

DESCRIPTION OF TIME-RANGE-RELATION RULER AND T-SQUARE

Developed by CORPORAL CHARLES F. HOUGHTON, 2nd Co., C. A. C., N. G., S. M.

DESCRIPTION

A light wooden ruler with a T-head mortised to the right end. On the upper edge of the ruler are set two posts, across which is stretched a chalk line. The T-head is graduated, on the scale of the time-range board, to include 100 yards, the smallest graduation being 10 yards. A small brass rod is fastened to the right edge of the head, on which slides a double brass pointer, adjustable for length. A handle is fastened on the ruler at the balance. The ruler is of light construction, weighing but a few ounces.

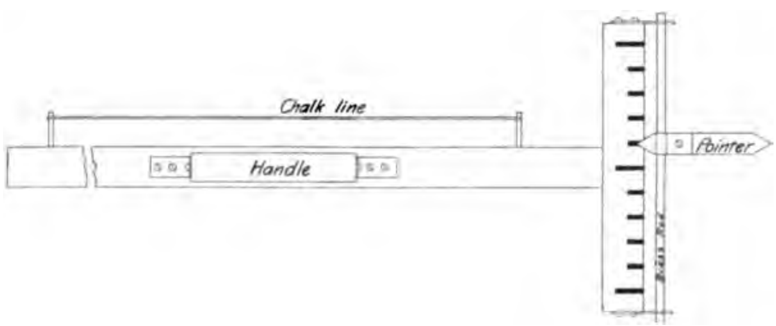


FIG. 1.

OPERATION

The ruler is held in the left hand throughout the practice. Two corrected ranges having been plotted on the time-range board by crosses, lay the ruler on the board the chalk line cutting both crosses and extending to the third time line. Snap with the right hand. If desired, the line between crosses may be sketched on heavier, freehand, indicating the track of the target, the light chalk line indicating the prediction. At the command "In Battery, TRIP," place the T-head on the

proper time line, the upper and lower graduations coinciding with heavy range lines. The pointer being adjusted for the normal interval between "Trip" and "Fire," bring the right pointer to the range curve and read proper corrected range on left pointer, according to Par. 400, C. A. D. R., 1914.

Advantages

Curve can be plotted quicker, easier, neater, and more accurately.

Can be adjusted and read more quickly and easily, and with as much accuracy, at the command "Trip," than the heavy, cumbersome T-square.

The same ruler used for both plotting curve and determining range. No necessity for laying down ruler and moving T-square.

SERVICE OF THE PIECE GAME*

A "Service of the Piece Game" has been issued to each company of the Coast Artillery Corps of the National Guard of New York.

This game was originated by Captain William A. Trull, 30th Company, Eighth Coast Defense Command, and it has been found to be a valuable means of instruction in the drill of the piece, in the nomenclature, purpose and functions of the various parts of the gun and carriage, and in the use of the equipment, implements, and stores accessory to the battery.

Although no dummy armament is installed in the Armory of the Eighth Coast Defense Command, Captain Trull has qualified eighty-five per cent of his company as second-class gunners, principally by the use of this game. It has been found that the enlisted men take a great interest in playing the game and that they become keen in detecting errors committed by the other players. The rivalry thus engendered is a valuable factor in instruction.

Instructions for the Use of the Game

The game is played by an instructor and as many men, within the number of details authorized for the caliber, as can be conveniently placed around the board.

The instructor opens the board (Fig. 1) and places it upon a table, removes the numbered cards (Fig. 2) from the pocket and envelope and places them in a pile before him. He removes from the pocket the rammer, sponge, and extractor and places them in a convenient place on the table. He removes from the pocket and envelope the cards (Fig. 2) representing the equipment, implements, and stores and places them in a pile in a convenient place. He then issues one of the number cards to each player.

At the command "*Details, Posts,*" each player takes from the pile the cards representing the equipment, implements,

* This description is taken from *Coast Artillery Bulletin No. 43, N. G., N. Y.*, and was furnished for publication through the courtesy of Lieut.-Col. W. Irving Taylor, C. A. C., N. Y.

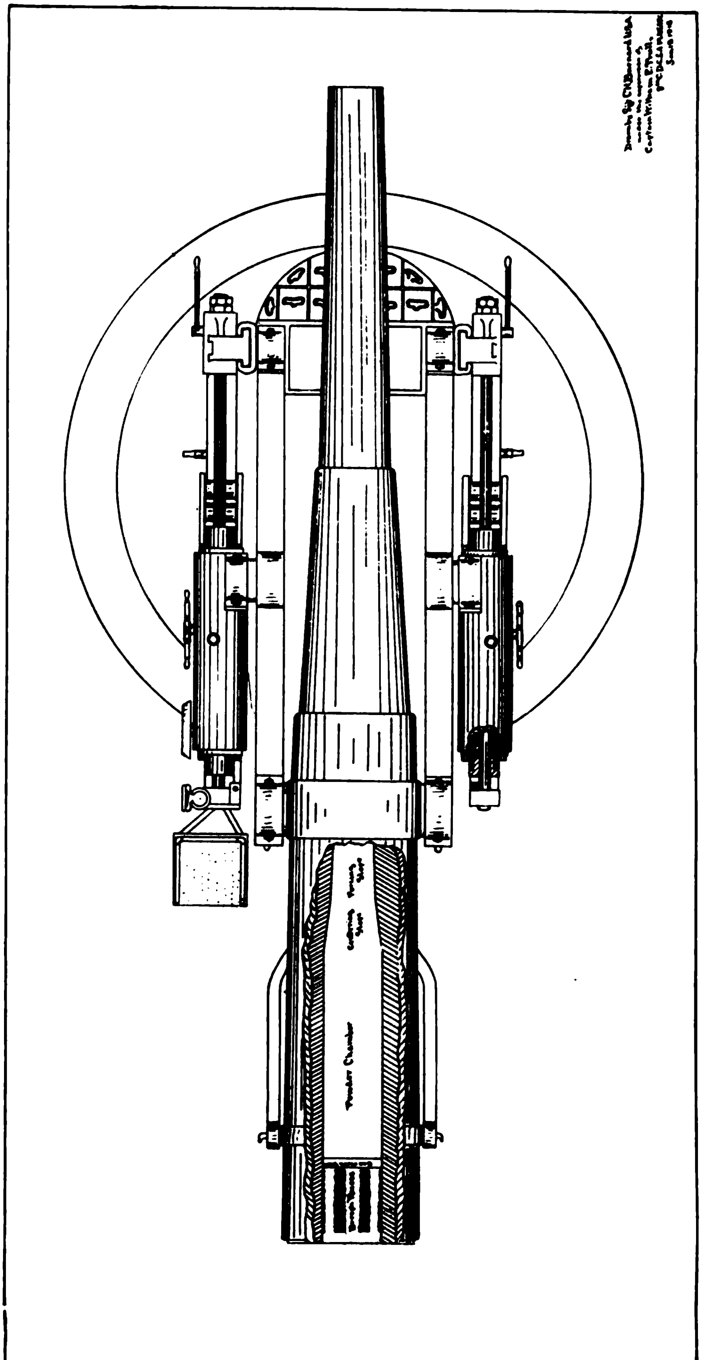


Fig. 1.

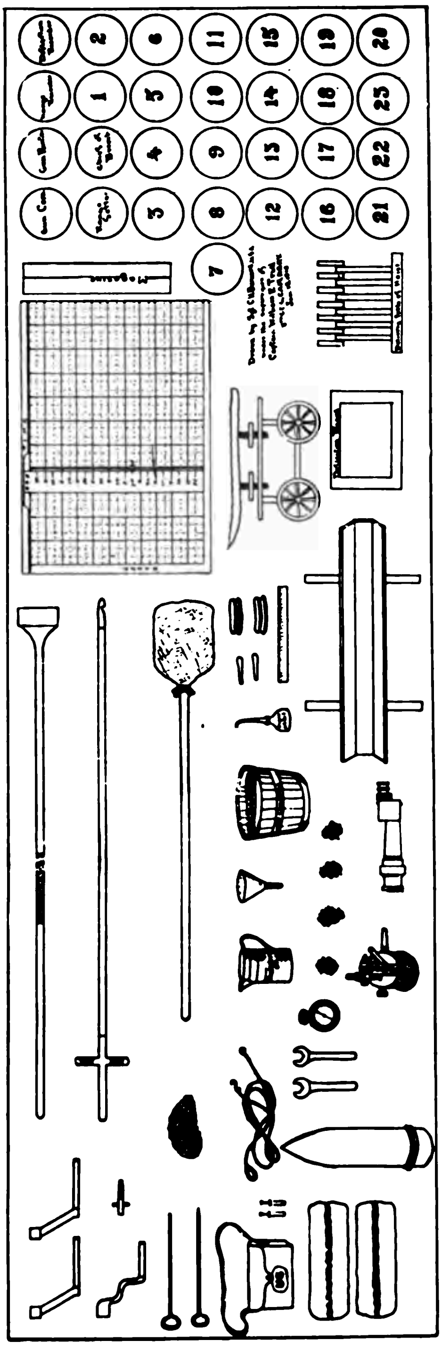


FIG. 2.

and stores which the detail corresponding to the number on the card issued to him, is required by D. R. C. A. to procure. Each player then puts the cards representing the equipment, implements, and stores drawn by him, in the places prescribed in D. R. C. A., and places the number card issued to him upon the board, in the position, at the piece or on the emplacement, prescribed in D. R. C. A. as the "post" of that detail.

At the commands "*Examine Gun,*" "*Load,*" and "*Cease Firing*" each player, in rotation, recites the duties performed by the detail represented by the number card issued to him, and taking up the appropriate card representing the equipment, implements, or stores required, simulates the motions made by that detail.

The instructor corrects errors and explains the various parts and functions of the gun and carriage. By changing the number cards issued, each player is made to perform, in turn, the functions of each detail.

THE LOCATION OF COAST FORTS AND THEIR LAND DEFENSES

By Major HAROLD E. CLOKE, Coast Artillery Corps

It has many times occurred to the writer that in the selection of sites for the various fortifications comprising the coast defenses of this country, the question of their land defense was not always given due weight or consideration. The construction of seacoast fortifications is *always* a live question. The United States has more seacoast to take care of and more harbors to protect than any other nation in the world.

Although considerable has been done towards accomplishing an effective blockade against any foreign navy at most of our important sea ports, there still remain many vulnerable points unprovided for. It is therefore with a view to the future that it is our duty to survey what we have done, are doing, and are going to do, in order to eliminate errors in the future and correct the errors of the past. Now that the question of preparedness and national defense has seized the mind of the country with a force almost akin to panic, the subject of this essay becomes a still more active one.

The fundamental principle of coast defense is "to keep the enemy out." The mission of the enemy would be to subdue us by an invasion of our coast ports, destroy our sources of custom revenue, secure a basis of supply, seize our richest revenues and financial resources and demand war indemnities.

There are two ways this mission could be accomplished: first, to reduce the coast forts which command the entrances to our water ways of commerce by naval attack; second, to reduce these forts by land attack. The basic principle, therefore, in the location of coast forts should be to so place them as to render them as invulnerable to land attack as possible. The theoretically perfect coast fort would be an island with precipitous slopes so located as to command all entrances to a harbor, and possessing a superiority of fire over any fleet

that any enemy could send against it. It should be self contained, that is, supplied with stores, water, quarters, ammunition, etc., sufficient to withstand an indefinite siege by water, land, or air. So long as such a fort holds out, the mission of the enemy to obtain a permanent foothold would be thwarted.

The armament of the ideal fort should possess the following requisites:

a. Superiority of fire.
b. Superiority of range.
c. Superiority of hitting power (hits per gun per minute).
d. Superiority of armor penetration.
e. Superiority of concealment and protection.

It is the writer's opinion that all types of armament should be reduced to the following:

a. Mortars, with a range of 30,000 yards.
b. 16-inch rifles.
c. 6-inch rapid fire guns (fixed ammunition).
d. Submarine mines, nets, and boats.
e. An aerial fleet for scouting and fire direction purposes.

It is not the intention of the writer in this short essay to review the entire history of coast fortifications in this country. In surveying the subject, however, from a retrospective standpoint, one cannot help but see the foolish policy of suddenly preparing for war when war is declared.

The pages of history from the time when gunpowder was first invented show that coast defense fortifications have fulfilled the purpose for which they were designed when they have compelled the enemy to proceed to an attack against them by land. All students of military history admit this. Therefore, let us look with a more covetous eye towards the land defenses of our coast forts. To fail to utilize everything in our power in time of peace to render our coast defenses impregnable to land attack in time of war, should be construed as a gross neglect of duty.

The old system of fort construction, as perfected by General Totten immediately after the Civil War, seems to have been entirely lost sight of and forgotten.

The self-contained fort, with its bastions, scarps, galleries, and moats has become a relic of the past. Old Fort Knox, opposite Bucksport on the Penobscot River, Maine, was a

most excellent example of this old type of fort. Here the site selected was on a bend of the river, giving almost 300 degrees of fire, with its towering battlements reaching a height of 200 feet, secure from front attack by an almost perpendicular wall of stone and cut off from the rear by moats and steep granite walls. In the interior of the fort, there still remain, in a fair state of repair, the quarters of officers and men, the water system, store rooms and casemates for supplies; in fact, this fort was designed to resist attack, no matter what its character or from what direction it came, for an indefinite period.

It is now realized, when we study coast guard problems, what tremendous difficulties might have been obviated had land defense features been more thoroughly considered.

That the land defense of coast forts was not seriously considered is evident from the manner in which batteries were scattered in some of our forts and also the failure to utilize the value of the islands which nature has placed at the entrance of many of our fortified harbors.

Another difficulty with scattered batteries is the communication problem. If one battery be put out of action, a safe way to send the troops that manned it to another battery should be provided. This has never been done. In some forts there are not even roads connecting them.

To say that all this work of constructing trenches, stockades, walls, obstacles, roads, and parapets could be done on the outbreak of war is a serious mistake.

In estimating this situation, a few examples are offered and plates submitted herewith. Concrete cases always appeal more to the average mind than those in the abstract, and pictures tend to appeal more to the rapid peruser. I have therefore selected some particular cases with the hope that they will illustrate the points at issue with a view to opening up discussion and argument on this subject, so that we may be better prepared if the hour of war should ever come.

Problem One

The situation shown in Fig. 1 illustrates a harbor with four routes of egress, *A*, *B*, *C*, and *D*. Route *A* is a narrow and circuitous channel but of a sufficient depth for battleships. *C* is also a narrow channel but only deep enough for lighter craft. *B* and *D* are almost perfect harbor openings. The two islands shown in heavy outline have steep, precipitous cliffs and rocky shores to the seaward. Submarine mining is

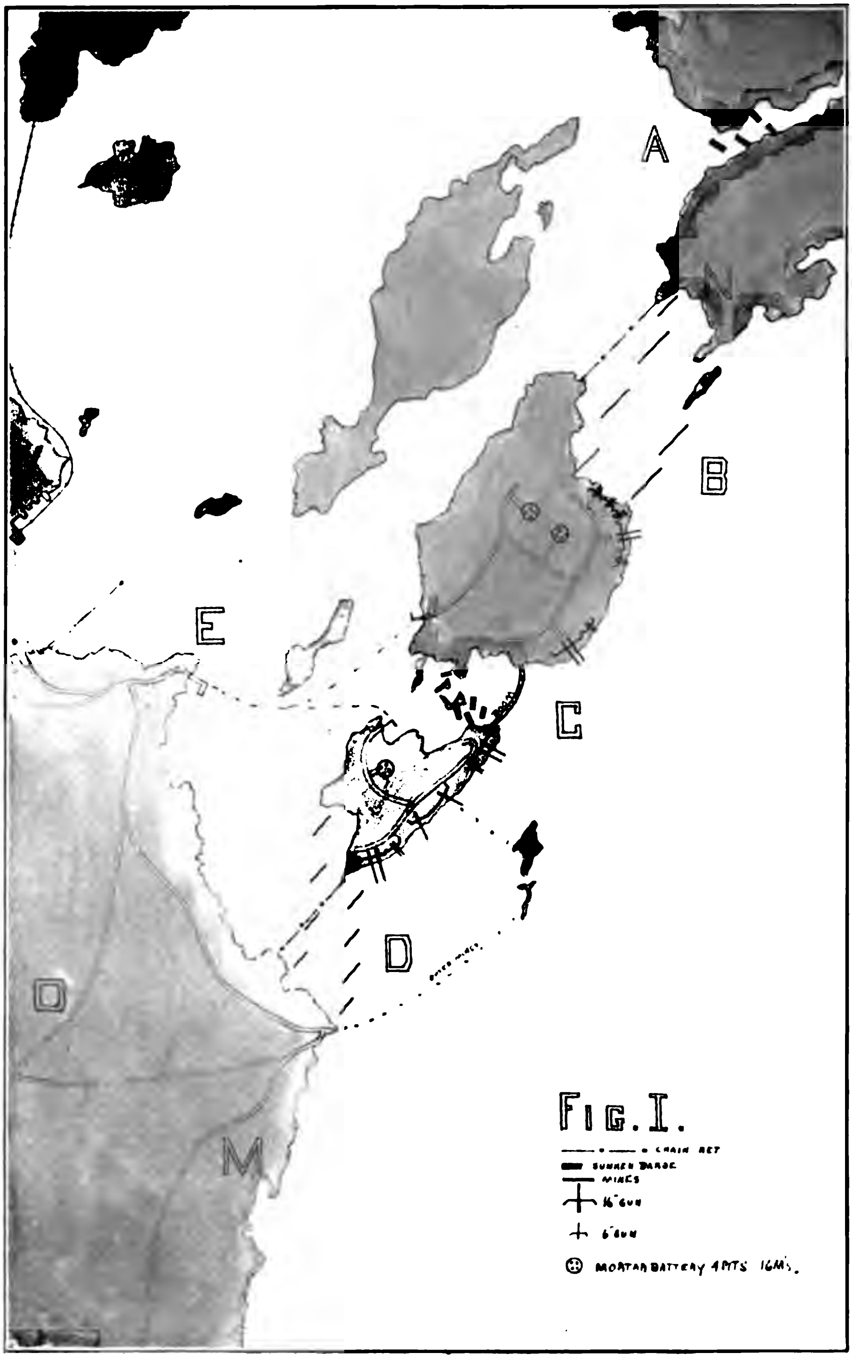

A
B
C
D
E
O
M
CHAIN NET
SUNKEN BARGE
MINES
16" GUN
6" GUN
MORTAR BATTERY 4 PITS 16 M's.

FIG. I.

1815

possible in both channels *B* and *D*. There is an electric trolley connecting *E* and *X*. Transcontinental lines connect at *X*. It would be practicable and comparatively easy to block the channels *A* and *C* with sunken rock barges which could be raised after war is over. Channels *B* and *D* could be blocked against submarine attack on a fleet in the interior waters as shown by the chain nets.

Bombardment of the city *X* would be prevented by the superior range and accuracy of the primary armament (16-inch guns and mortars). Raids and attack on the mine fields could be met by guns of the secondary armament (6-inch rapid fire). Land attack would be rendered exceedingly difficult for the reasons that the two forts are located on islands and the seaward slopes are precipitous. A land attack by way of either *M* or *N* would first be met by the coast guard army. In either case most of the primary and secondary armament, especially mortars, could be used against any planned siege from either *M*, *N*, *O*, or *E*. It is held that nothing of importance of a permanent nature would be accomplished by the enemy until these forts were reduced.

PROBLEM TWO

The situation shown in Fig. 2 is a most difficult one. In this case nature has been far from gracious in affording means of natural defense.

The distance from *B* to *D* is about 10 miles. Too great for absolute assurance that the enemy's fleet could not slip through between *A* and *E*.

The problem then resolves itself into one of devising some artificial means by which this distance may be shortened. After a further study of the situation, it is seen that there are shoals at regular steps between *D* and *E*, about one-half mile apart. At *A* there is a decided shoal of considerable area averaging 16 feet in depth. If the island *D* had been located by nature at *A*, the problem would be solved. But in as much as money is of no consideration, and it is possible to construct an artificial island at *A*, this would be the first step towards the practical solution of the problem. The terrain at *B* affords excellent opportunity for the construction of an artificial moat which would render a fort at this place more difficult to attack by land. Taking advantage of the natural shoals between *D* and *E*, small artificial shoals could be constructed as links to an artificial barrier. These would be built in time

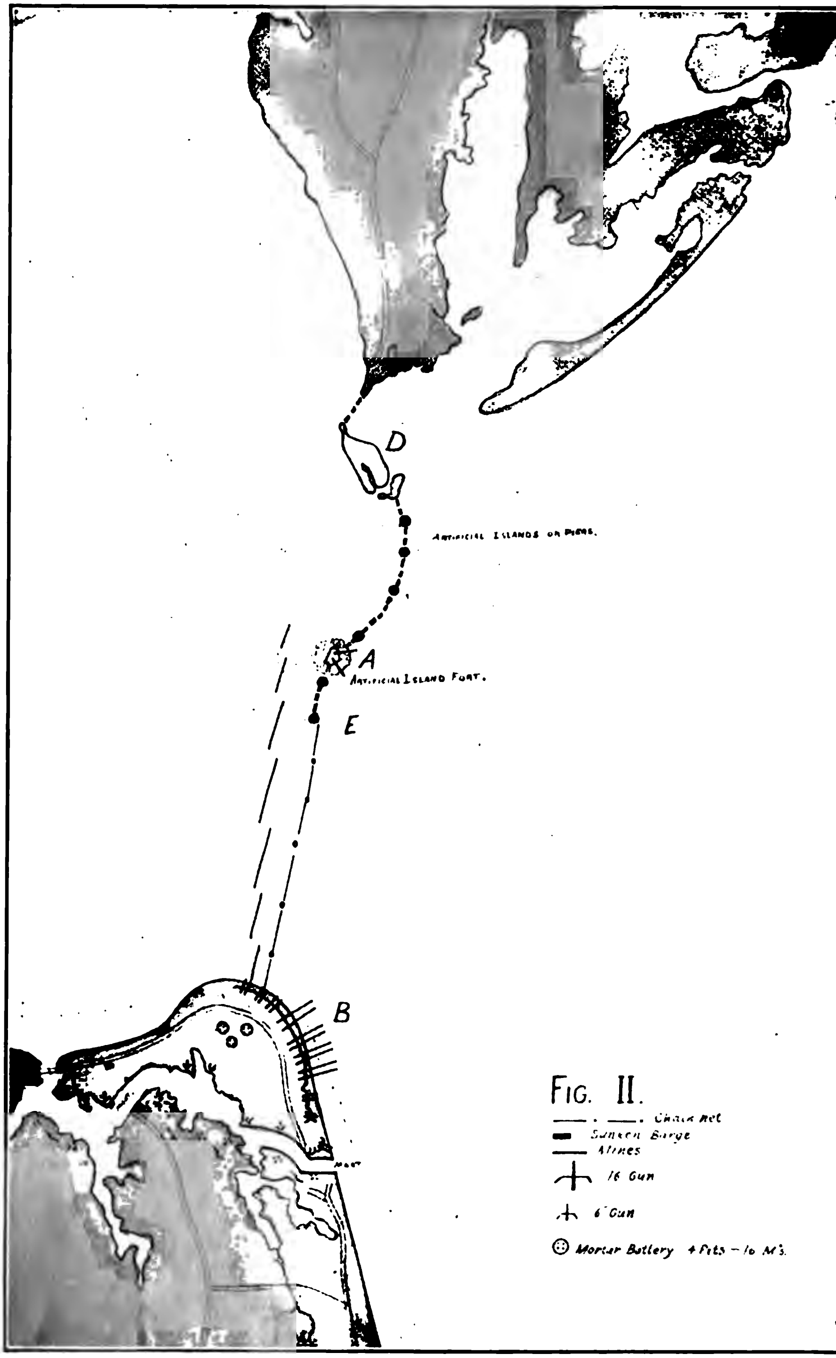

D
A
Artificial Island Fort.
E
B
Sunken Barge
16 Gun
6" Gun
Mortar Battery

FIG. II.

of peace. Between these shoals and between *C* and *D* would be sunk barges loaded with rock. Mines, booms, etc., could also be resorted to. Between *E* and *B* a chain net could be planted to protect a fleet in the inner waters against submarine attack. Mines would also be laid. The artificial fort at *A* would be of the turret type with two 16-inch guns supported by four 6-inch rapid fire. The armament at *B* would be eight 16-inch and twelve 6-inch guns, with forty-eight mortars in the rear and completely concealed.

The probable methods of attack would be as follows:

a. An attack by submarines against our fleet bottled up inside. This would be met by the chain net.

b. A raid at *A* and *E* to destroy the chain net. This would be met by the secondary armament at *A* and *B*.

c. A run-by in the fog or under a smoke screen. This would be met by the submarine mines.

d. A land attack against *B*. This would first be met by the coast guard, and further advance prevented by land mines, charged wires, obstacles, and, finally, the moat and the last line of trenches with field and machine guns at the salients.

e. A bombardment or open run-by would be met by superiority and accuracy of fire.

Problem Three

In this problem there are two avenues of entrance, *A* and *X*. *A* is a narrow and circuitous channel, but deep enough for vessels of the cruiser class. *X* is a perfect harbor entrance for all classes of ships. The distances *EF*, *EG*, and *FG* are about 7000 yards each (an equilateral triangle).

The distance between *B* and *C* is 16,000 yards. Between *D* and *C*, about 10,000 yards. *C*, *F*, *B*, and *G* are on islands. *C* and *F* are easily protected from land attack on account of the narrow neck at *C*. *G* is easily protected from land attack by virtue of its being on an island and most of it covered with impenetrable forests. *M* and *P* are also easily defended bridge heads. *B* is a natural island with a flat top about 100 feet above the water and steep slopes all around. *D* and *E* would require a considerable army to defend them from land attack.

Submarine mining is exceedingly difficult except at *A* and *Y*.

The armament at *B* would be two 16-inch guns, eight

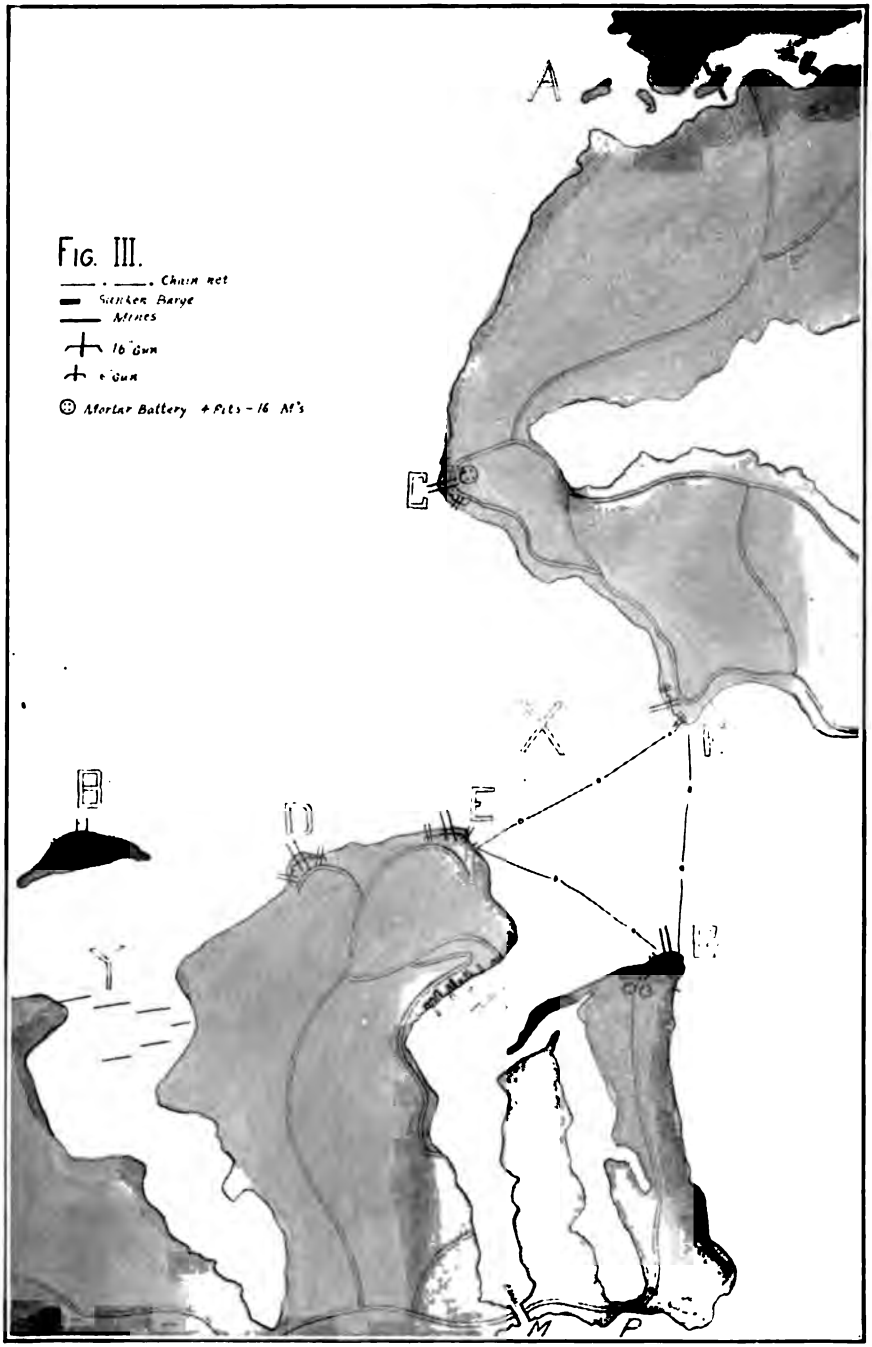


Fig. III.
Chain net
Sunken Barge
Mines
16" Gun
Gun
Mortar Battery 4 Pits - 16 M's
A
C
X
B
D
E
Y
M
P

1817

mortars, and four 6-inch guns. *At C* the same. *At D, E,* and *F* two 16-inch and four 6-inch guns. At *G* two 16-inch and two 6-inch guns, and thrity-two mortars.

The probable methods of attack would be:

a. A run-by in a fog or under cover of a smoke screen.

Either would be hazardous on account of the treacherous tides and the difficulty of navigation due to continuous variations in the course. Such a move would be met by a fleet of submarines held in readiness at *Z*, and dirigible torpedo stations at *E*, *F*, and *G*. An aerial fleet would be also utilized so that salvo and interval firing could be resorted to by the three forts, *E*, *F*, and *G*.

b. An attempt to force the passage at *A*.

This passage would be blocked by stone barges and blasting out the sides of the slopes with charges prepared in advance, the debris falling into the channel.

c. A land attack against *D* and *E*, by way of *Y*.

This would be met by guns and mortars from *B*, and also from mortars at *G*, and mines at *Y*. In case *B*, *D*, and *E* were reduced, and the guns utilized against *C*, *F*, and *G*, their fire would be silenced by the mortars and guns at *C*, *F*, and *G*, by using the square system of indirect fire.

d. Submarine attack against a fleet in the inner waters.

This would be met by the chain net stretched between the three points of the triangle.

There is no town or city of any financial importance that could be bombarded by the enemy without the fire from these forts being able to establish their superiority.

The presentation of the subject of the absolute necessity of this country preparing for war in time of peace cannot be made too forceful. A necessity which is ever increasing as time progresses by reason of the suddenness with which modern wars have been declared.

A REMINDER LIST FOR BATTERY OFFICERS

Issued by the Department of Artillery and Land Defense,
Coast Artillery School

1. Base rings tested for level before the heat of the day, preferably soon after daylight?

a. Clinometer adjusted and each gun leveled when pointing on a line perpendicular to the azimuth Directing Point-Pintle Center? Range scale checked and index set at this azimuth?

b. Amount base ring is out of level + or − determined and tabulated at 5° intervals?

c. Chart constructed showing range difference [see 2 (c)] and level difference (effect in yards) for approximate range at which practice will be held for each gun?

d. By charts (c) have range indices been shifted, or new "gun differences" been lettered on steps between gun and loading platforms?

2. Sight standards adjusted on a long range datum or object?

a. Guns oriented to indicate true azimuths (for analysis purposes)?

b. Assuming lines of sight from the directing point at 10° intervals over probable field of fire, has the length of the perpendicular from each gun to each such line of sight been computed, tabulated, and the results plotted on a chart? (For computing azimuth differences from each gun for any azimuth and range of the target by the formula lateral yards = .0175RD°.)

c. Has the distance from the base of each perpendicular to the directing point been computed and plotted on a chart for determining range differences at different azimuths from the directing point?

d. Has the azimuth setting of each gun been determined so as to make them converge on the aiming point for trial shots?

3. Elevating mechanism cleaned and oiled?

4. Friction devices of elevating mechanism cleaned and adjusted?

5. Traversing mechanism cleaned and oiled?

6. Recoil cylinders cleaned and filled?

7. Recoil and counter recoil system:

a. Elements cleaned and lubricated?

b. Settings of throttling and buffer valve co-ordinated and adjusted for temperature?

8. Breechblocks dismantled, inspected, cleaned and lubricated, and adjusted on the day of practice?

9. Gun commanders instructed in preparation and use of pressure plugs? (See O. P. 1738.)

a. Cylinders calipered and arranged for identification both for use with a particular shot or series, and for measurement after the firing?

b. Tarage table on hand for particular metal used?

c. Proper cylinders selected for range of expected pressures?

10. Firing mechanism cleaned, oiled, and adjusted?

a. Electrical contacts firm and free from oil?

b. Bodies and button of electric primers clean and free from oil and shellac coating?

c. Primers tested for circuit?

d. No. 3 of breech detail at each gun furnished with sufficient supply of primers to fire entire series? (In case ammunition is transferred.)

e. No. 3 at each gun instructed to place used and defective primers at place where they will not be used again by mistake?

f. No. 3 at each gun instructed in use of long lanyard at subcaliber in case the electric firing mechanism fails in service?

g. Gun pointers practiced frequently at subcaliber in firing by electricity?

h. Firing circuits thoroughly tested for circuit where there should be circuit, and no circuit where there should be none?

i. Primer fired in each gun electrically as final test a short time before practice?

j. Proper number of breech detail thoroughly instructed in all safety precautions regarding method and time of inserting primers, as prescribed in drill regulations?

k. Saftey devices of breechblocks tested? (See O.P.1678.)

11. Mortar azimuth subscales verified? (Preferably by transit on parapet at approximately the elevations at which fired.)

12. Mortar quadrants tested and adjusted?

a. Mortar elevation scale indices adjusted?

13. Gun pointers instructed in adjustment of the sights for definition and parallax independently?

14. Shot trucks cleaned and adjusted?

15. Bores and chambers freed of grease and dirt?

16. Guns tripped and retracted frequently just before practice?

a. Tripping detail instructed in verifying the fact that the gun goes completely into battery for each shot? Signal given to gun commander?

17. Projectiles:

a. Paint removed?

b. Bourrelets polished?

c. Rotating bands cleaned, and oil and dirt removed from grooves?

d. Rotating bands calipered and projectiles classified by weight?

18. Scale on hand and checked for measuring seating of projectiles?

19. Powder blended?

a. Scales adjusted previous to weighing?

20. Communications inspected?

21. Primary and Secondary and B. C. instruments tested for adjustment and orientation?

a. Observers thoroughly instructed?

22. Plotting board elements checked and verified?

a. Operators thoroughly instructed?

b. Does gun arm indicate correctly the range and azimuth of the aiming point from the directing point when the B′ and B″ arms are set to the computed azimuths of the aiming point?

23. Chart constructed showing how to adjust the center of impact to the center of the record target, expressed in terms of feet of tide?

24. Range board in careful adjustment?

a. Operator thoroughly instructed?

b. Any creeping of correction ruler?

c. When a pointer is set to a normal, does it follow the normal when the ruler is raised or lowered?

d. Proper range correction chart used for caliber of gun, normal muzzle velocity, type of projectile, and height of site?

25. Deflection board in careful adjustment?

a. Operator thoroughly instructed?

b. Operator understands how to apply a correction to the deflection when announced by the battery commander?

c. Proper wind arc, leaf range scale, and T-square scale used for caliber of gun, normal M. V., and type of projectile?

26. Time-range-board operator thoroughly instructed?

27. Time interval bell and all telephones and switches in adjustment and functioning properly?

28. Battery commander satisfied that the data received from the meteorological station is uniformly accurate and that the observers there are to be relied upon?

29. Work of personnel uniform and accurate?

a. Substitutes properly trained?

b. Individual work checked throughout the system?

30. Instruments for the determination of range errors properly checked up and operators thoroughly instructed?

a. Camera records checked?

31. Proper Velocity Graphic Chart on hand to determine the velocity developed by the trial shots, for the caliber of the guns, normal muzzle velocity, type of projectile, and height of site?

a. If the velocity graphic chart supplied does not have sufficient range, has one been improvised for the practice? Check with range board determination of M. V.?

b. Temperature of powder carefully determined both for trial and record shots?

c. Muzzle velocity assumed for trial shots carefully worked out from study of previous firings with same lot from guns having similar chambrage?

d. M. V. for record shots determined independently by velocity graphic chart and range board? Do they check?

32. Was advantage taken of probable error cards of this battery?

WHY WEAKENING THE FIELD OF A SHUNT MOTOR WILL INCREASE ITS SPEED

By Electrician Sergeant, First Class, THORNTON A. LEMASTER, C. A. S. D.

One of the most perplexing problems with which the student of direct current motor control has to deal is that of finding some tangible reason why weakening the field of a shunt motor will increase its speed.

Many text-books are not very plain in their explanations of this subject and in some it is stated that "The motor has to run faster in order to develop the same counter electromotive force." Such a statement and others similar to it would seem to indicate that the shunt motor was a sensible, responsible being and had entered into a contract to develop a certain counter electromotive force regardless of conditions.

This, however, is not the case, and the shunt motor is only a mass of cold metal which can do only what it is made to do, and therefore the only thing that will increase the speed of rotation in a shunt motor carrying a constant load is to increase the torque.

The purpose of this article is to show by simple arithmetic how this increase in torque is accomplished by weakening the field.

In the first place, the thing that causes rotation in a motor is the reaction between the magnetic fields produced by the current in the armature and field winding, and since the reaction between two magnetic fields is proportional to the product of the two fields, and since the strength of the armature field is proportional to the current flowing in the armature, we may say that the torque is proportional to the product of the armature current times the strength of the field.

Now, in the accompanying sketch, suppose that the armature resistance is 1/20 of an ohm, and that the motor is loaded until it takes 20 amperes through the armature, with an E.M.F. of 101 volts applied to its terminals.

Then the armature IR drop equals $1/20 \times 20 = 1$ volt; and the counter E.M.F equals $101 - 1 = 100$ volts.

Now, suppose we call the field excitation under these conditions 100 per cent of its present value (which it is). Then if 100 per cent field excitation would develop 100 volts counter E.M.F., 1 per cent field excitation would develop 1 volt at the same speed. Under these conditions, we may say that the torque is proportional to 100 per cent field excitation $\times$ 20 amperes.

Supposing, then, that we weaken the field by 1 per cent of its original value, the counter E.M.F. at the same speed would be 99 volts and there would be available $101 - 99 = 2$ volts to send current through the armature, which would give us $2 \div 1/20 = 40$ amperes in the armature, and the torque

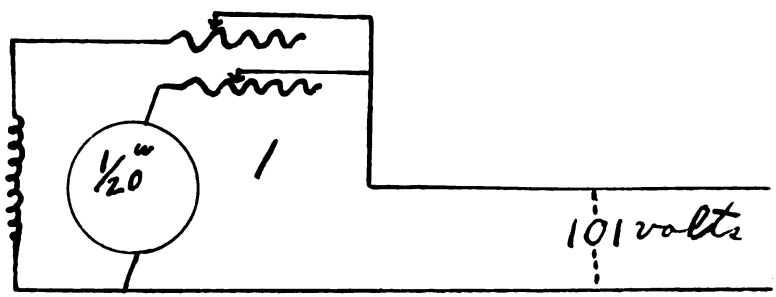


FIG. 1. 1818

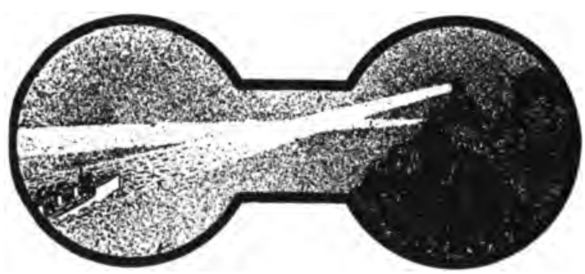
would be proportional to 99 per cent field excitation $\times$ 40 amperes, which is greater than 100 per cent field excitation $\times$ 20 amperes, and therefore since the torque is increased, the speed will also increase.

It will be noticed that by decreasing the strength of the field by 1 per cent we increase the armature current by 100 per cent.

In like manner it may be shown that a shunt motor is developing its maximum torque when the counter E.M.F. is equal to one-half the applied E.M.F., for in this same motor, suppose the field to be reduced to one-half its original value, then, if the speed had remained constant, the counter E.M.F. would be 50 volts and the armature current would be 51 volts $\div$ 1/20 ohm = 1020 amperes.

Now if we weaken the field by 1 per cent of its original value (which would be 2 per cent of its value when the counter E.M.F. was 50 volts), we will increase the armature current by 20 amperes, which would be less than 2 per cent of the

armature current under these conditions, and since the field strength has been decreased by a greater percentage than the armature current has been increased, the torque—and therefore the speed—will be decreased.



PROFESSIONAL NOTES

FORTIFICATIONS

Prepared by the War College Division, General Staff Corps as a Supplement to the Statement of a Proper Military Policy for the United States

Introduction

In a memorandum from the Chief of Staff dated November 15, 1915, directions were given for the preparation of a brochure upon the subject of "Fortifications," with sole reference to the present European war, giving especial attention to the following points:

a. What influence forts and fortified cities, as distinguished from intrenched areas, have exerted on the operations on land.

b. Influence of seacoast fortifications with particular reference to the attack of the allied fleet against the fortifications of the Dardanelles. Give in detail the total armament, with calibers of arms of the fleet as well as of the land forts, and the losses in personnel and material suffered by both fleets and forts.

c. A brief summary of the attempt to take these forts by the operation of the mobile troops; the number of mobile troops, as near as can be determined, used to date, both in the attack and in the defense, with total losses.

This has been done as far as practicable with the data now available, and the results are noted in the following paragraphs:

1. Influence of Forts and Fortified Cities, as Distinguished From Intrenched Areas, Upon Operations on Land

FORTIFICATIONS OF LIEGE

At the outbreak of the present European war the Germans, in their march through Belgium, were, on the evening of August 4, 1914, closing in on Liège, which lies astride the Meuse River near the eastern boundary of Belgium. The fortifications of Liège had been constructed by Brialment, a Belgian officer, who also designed the fortifications of Namur and Antwerp. They were completed in 1892, and consisted of a circle of forts commanding the main approaches to the city and about 4 miles therefrom. There were six main forts of the pentagonal type and six smaller, triangular in shape; the greatest distance between forts was 7000 yards, and the average less than 4000 yards. Each fort had a garrison of about 80 men and an armament of two 6-inch guns, four 4.7-inch guns, two 8-inch mortars, and three or four quick-fire guns, the total number of guns in the 12 forts being about 400. It was intended to construct between the forts lines of trenches and redoubts for infantry and gun pits for artillery, but this had not been done.

The fort itself consisted of a low mound of concrete or masonry, roofed with concrete and covered with earth; a deep ditch surrounded the mound, the top of the latter barely showing above the margin of the ditch. The top was pierced with circular pits, in which "cupolas" or gun turrets moved up and down. Within the mound there were quarters, machinery, stores, etc.

When the Germans appeared the Belgian mobilization was still in progress, and it is probable that the garrison, instead of being 30,000 as was intended, was only 20,000. The Germans, numbering about 30,000, concentrated the attack on the four forts at the southeast sector and opened up with field guns on the night of August 4–5. One of the forts was silenced by this fire on the 5th, and on the 6th the Germans brought up their 8.4-inch howitzers and probably some 11-inch mortars, outranging the Belgian guns. Shells are said to have gone through 12 feet of concrete. The accurate firing of the Germans showed that the forts could not long withstand, and in the afternoon of the 6th the Belgian field force was withdrawn from the city and all the forts abandoned except the northern ones. The Germans left the remaining forts in peace until the 13th, when the 11-inch mortars opened on them, and by the 15th all had been captured. The cupolas had been smashed and shells had penetrated the roofs and exploded the magazines.

FORTIFICATIONS OF NAMUR AND ALONG THE FRENCH FRONTIER

Namur was defended by a ring of nine forts, 2½ miles from the city, with an armament similar to that in the Liège forts. The garrison of 26,000 had prepared the defense of the intervals by intrenchments and wire entanglements, and a vigorous defense was intended, as French help was expected. The Germans brought up 32 modern siege pieces, including the 42-centimeter howitzer, its first appearance, and the Austrian 12-inch mortar, and placed them 3 miles from the Belgian lines. The attack began August 20. On the next day the Belgians had to withdraw from the advanced trenches owing to their inability to reply to the German fire; two forts fell; three others were silenced after an attack of two hours. On the 23rd Namur was occupied, and on the 25th the last fort had fallen. One fort had fired only 10 times and was itself struck by 1200 shells fired at the rate of 20 per minute. The speedy fall of Namur came near playing havoc with the allies' plans, as with the delay caused by its resistance they had intended to complete the concentration along the Belgian frontier.

Other fortified places, such as Lille, Laon, La Fere, and Rheims, along the northeastern French boundary fell before the advancing Germans without striking a blow. The advance was on such a broad front that an attempt at defense would have endangered the safety of the garrisons, and it was imperative that the garrisons join the field army. By August 28 Mauberge of all the northern strongholds alone held out. The defenses had been brought to a high state of efficiency, the intervals well prepared with an armored train running on a track encircling the main line of defenses. The German infantry invested the place August 27, but the siege guns did not go into action until September 3. The place fell September 8 with a loss of 40,000 men.

ANTWERP

Antwerp, said to be the second most strongly fortified city of Europe, encircled by a girdle of 20 permanent forts and 12 earthen redoubts, was

in similar manner quickly reduced by the heavy siege guns. The garrison, beginning to profit by the lessons learned at Liège and Namur, attempted to keep the enemy's big howitzers beyond range of the forts, but were driven back by the superior numbers of the Germans, whose siege guns were then brought up and quickly demolished the masonry forts. Thus the garrison was deprived of any further assistance from its larger guns and, being but poorly entrenched and unable to withstand the overwhelming artillery fire, was forced back to the inner line, thereby permitting the siege guns to come within range of the city, which had therefore to be abandoned promptly in order to prevent its destruction by bombardment.

VERDUN

Verdun, however, on the eastern French frontier, with a ring of forts 5 miles from the city, is still in the hands of the French, because with a field army employing earthworks the fortified zone has been largely extended and the German howitzers have been kept 6 miles from the forts. The unfortified city of Nancy has withstood several heavy attacks, being protected by a field army on the hills forming the "Grand Crown."

PRZEMYSL AND THE RUSSIAN FORTIFICATIONS

The Russians invested the fortress of Przemysl on September 22, 1914, but later the siege was raised and on November 12 it was invested a second time. As the Russians had no heavy siege guns, the siege resulted in an attempt to starve out the garrison, which succeeded March 22, 1915. With the return of the Teutonic allies in May, 20 days was sufficient to recapture the place. The Russians stated that their ammunition supply was low, but it is safe to assume that the presence of the heavy siege guns with the Germans had a great deal to do with the recapture.

The fortresses guarding Warsaw and the Russian frontier on the west were quickly taken during the advance of the Teutonic allies in the summer of 1915, either by maneuvering the defenders out of them or by bringing up the heavy guns and shattering the fortifications, as at Novo Georgievsk. The fortress of Ossowetz on the line Niemen-Bobr-Narew had a different history. In February, 1915, the Russians fell back across the Bobr River to the protection of Ossowetz, which stood on the east bank along a long ridge covered with woods, affording good artillery positions, and commanding the opposite bank, where artillery positions were poor. There were extensive marshes along the river, but at this time of the year they were frozen. The Germans at first tried to turn the position, but failing, brought up their heavy mortars, even the 42-centimeter howitzer. The Russian batteries were so well concealed that the Germans could not locate them and their big guns did no damage. The Russians silenced several batteries without suffering from their fire. As the warm weather advanced, the marshes made it difficult to emplace the heavy guns. Ossowetz did not fall until August 22 in the general Russian retreat after the capture of Warsaw.

THE FORTIFIED CITY OF THE FUTURE

The failure of the forts in the present war is due to several causes:

First. Being built some years before the war, their position was accurately known to the enemy, thus losing the advantage of concealment;

also, the details of their construction leaked out and guns were especially designed to destroy them.

Second. Their armament had not been kept up to date and was entirely overpowered by guns of recent construction and of a type unknown to the defense.

Third. The garrisons permitted the enemy to emplace his guns within their effective range, but beyond range of the forts' guns.

The favorable effect of concealment, as a defensive measure, is illustrated by the operations against Ossowetz, and that of keeping the enemy at a distance by the operations against Verdun.

The experiences of this war confirm the conclusion reached during the siege of Port Arthur in 1904, "that the mounting of large-caliber guns in a fort for use against the siege guns of the enemy is a fatal error." It would therefore seem preferable to place the fixed heavy guns in emplacements located in rear of the line of forts, depending for protection upon concealment rather than masonry or other cover. The forts themselves, whether permanent or improvised after the outbreak of war, should be designed for an infantry garrison only, and the main line of defense should consist of a continuous system of infantry entrenchments (including machine-gun emplacements), located in advance of the line of forts. These latter would serve mainly as supporting points for organizing a counter attack in case the front were penetrated.

To check the enemy's advance before his heaviest guns have reached points within effective range of the city, naval base, or other vital object to be protected, a garrison sufficiently strong to operate well in advance of the forts, is indispensable, and its action should be assisted by long-range fire from the fixed armament, which should be superior in caliber and range to the guns usually supplied to an army in the field.

The guns of the fortress, both fixed and mobile, should be distributed over a large area and advantage taken of the terrain to secure concealment, which must be had at any price. It is important to bear in mind that the number of guns permanently emplaced should be comparatively small compared with the total heavy armament of the fortress, or, in other words, the main reliance will be placed on the mobile guns, some of which should be at least as powerful as any the enemy can bring against them.

The fortress of the future should consist of a large area so organized as to insure extreme mobility both to troops and guns. There will be no conspicuous forts of masonry and armor. Permanent gun emplacements should be constructed only at important points with the primary intention of compelling the enemy to lose time in bringing up his heaviest siege guns. The mobile guns would be located in earthen emplacements well concealed from the enemy's observers who might endeavor to direct fire on them. The point to be emphasized is that unless the garrison be strong enough in both mobile troops and mobile guns to keep the enemy from breaking through the line or coming within effective range of the city proper or other vital point or object to be protected, then there is no hope of offering a prolonged resistance.

In view of the foregoing it is apparent that intrenched areas with mobile troops and guns are a more dependable protection than a stereotyped system of permanent forts.

2. Influence of Seacoast Fortifications, with Particular Reference to the Attack by Allied Fleet on Dardanelles Fortifications

DESCRIPTION OF THE DARDANELLES

The western approach to the city of Constantinople from the Aegean Sea is through the Dardanelles and the Sea of Marmora. The Dardanelles (ancient Hellespont) is a long winding channel, 47 miles in length, but the really narrow portion, extending from the Aegean Sea to the town of Gallipoli, represents a sea passage of about 33 miles. The passage is at no point wider than 7000 yards, and at one point, the Narrows, 14 miles from the entrance, it contracts to 1400 yards. The surface current flows westward into the Aegean at an average speed of 1½ knots, which is sometimes trebled in the Narrows after strong northerly winds. The depth in mid-channel varies from 25 to 55 fathoms, and there are shallows at some of the bays in the wider sections. Owing to the narrowness, the strong current, and the cross currents set up at some of the bays, maneuvering of large vessels is difficult. The weather is treacherous and uncertain; the prevailing winds for nine months of the year are northeasterly, but south winds spring up quickly, and blows last from three to five days. Unfavorable weather and frequent haze and mist were encountered during the earlier stages of the naval operations.

The long narrow tongue of land to the north is the Gallipoli Peninsula. It has its greatest width, 12 miles, just above the Narrows or opposite Suvla Bay; it is narrowest at Bulair, 3 miles; at the Narrows the width is 5 miles. Ships can therefore lie in the Gulf of Saros and fire across the peninsula. The Asiatic shore of the Dardanelles is lower than the European. The hills are low and wooded, while on the peninsula they are bare and rocky cliffs. On both shores there are heights which give advantage to defensive artillery and at the Narrows both shores tower above the ships.

FORTIFICATIONS OF THE DARDANELLES

The original fortifications were the "Dardanelles Castles"; the two inner, the "Old Castles," at the Narrows, were built by the Sultan Mohammed II, the conqueror of Constantinople, in 1462; the two at the entrance, the "New Castles," were built in 1659. At the instigation of Great Britain new fortifications were built in the Narrows between 1864 and 1877. After the peace of San Stefano in 1878 the Germans designed new fortifications and all the new fortifications were armed with Krupp guns.

From the best obtainable information, in the Spring of 1915 the armament was as follows: At the entrance between the towns of Sedd-el-Bahr near Cape Helles on the European side, and Kum Kale on the Asiatic side, there were four forts or batteries, two on each side, with an armament of ten 10.2-inch guns, four 9.2-inch guns, and two 6-inch guns.

Proceeding towards the Narrows, there were on the Asiatic side fortifications on Dardanes Hill, 4 miles south of the Narrows, and two forts at the Narrows near the town of Chanak—the whole mounting an armament of four 14-inch guns, six 10.2-inch guns, one 8.3-inch howitzer, and nine 6-inch guns. On the European side there were three batteries south of the town of Kilid Bahr at the Narrows, and a number of batteries on the hills around Kilid Bahr, the total armament being four 14-inch guns, one 11-inch gun, eight 10.2-inch guns, fourteen 9.2-inch guns, fifteen 8.3-inch howitzers, and

twenty-four 6-inch guns. The armament between the entrance and the Narrows thus amounted to eight 14-inch guns, one 11-inch gun, fourteen 10.2-inch guns, fourteen 9.2-inch guns, fourteen 8.3-inch howitzers, and thirty-three 6-inch guns.

The fortifications extended 4 miles farther north to the line through Nagara, beyond which the Dardanelles turns to the northeast and broadens out. The armament on both sides amounted to two 14-inch guns, five 10.2-inch guns, five 9.2-inch guns, eight 8.3-inch howitzers, and fifteen 6-inch guns, all except six 6-inch guns being on the Asiatic side.

In addition to the above there were smaller guns to protect mine fields.

From an examination of the chart, it seems that a hostile fleet, after silencing the guns at the entrance and proceeding towards the Narrows, would be subject to the fire of the following guns when it had reached a point 4 miles from the Narrows: ten 14-inch guns, eighteen 10.2-inch guns, eight 9.2-inch guns, twenty-one 8.3-inch howitzers, and thirty-seven 6-inch guns.

Power of the Guns

The guns in the batteries vary greatly; alongside old guns are guns of very great power. The heaviest gun, of which there were 10, the 14-inch Krupp, with a projectile weighing 1365 pounds, appears superior to our 14-inch seacoast gun with its 1600-pound projectile, as it has a reported penetration in Krupp hardened steel armor at 8000 meters of 20 inches, while our gun has 16.3 inches. Its life, however, is limited to 80 or 90 rounds, and hence it is probably not as accurate as ours after firing a number of shots.

The next heaviest gun is the 11-inch, but there was only one of that caliber. Then comes the 10.2-inch, of which there were 29, a gun manufactured some years ago by the Krupps. It is not as powerful as our 10-inch gun; its projectile weighs 450 pounds, as against our 575 pounds, and its penetration at 3000 meters is 6 inches, while our gun penetrates 9.3 inches at 8000 meters. The other heavy-caliber gun is 9.2 inches, of which there were 25, with a projectile weighing 420 pounds, and still more inferior to our 10-inch gun.

It is believed that Krupp guns of later pattern were mounted after the outbreak of hostilities in 1914, and it seems to be certain that heavy mobile howitzers or mortars were used against the allies.

Character of the Batteries

The batteries were built with great care, but groups were formed of different calibers and types, which rendered serving them difficult and slow in action. The emplacements are of concrete and steel with earthen cover, with guns in embrasures rather than in turrets. There was a modern system of searchlights, telephones, and range finders, and good communication by roads. They were generally invisible from the sea, but their positions were detected by the stone barracks, which were usually close behind them and in full view of passing ships.

One of the batteries was manned entirely by Germans, but the others had Turkish crews that had been drilled by German officers. The movable howitzer batteries appeared to have had German coast artillerymen with *German naval officers in command.**

* The italics are the Editor's.

REDUCTION OF THE FORTS AT THE ENTRANCE

On November 3, 1914, the allied fleet bombarded the forts at the entrance, but the real operations began February 19, 1915, with a fleet of British battleships and cruisers, aided by a strong French squadron. The attack was at first at long range, to which the forts could not reply, being outranged. In the afternoon the ships closed in and opened fire with the secondary batteries; the forts returned the fire. The forts on the European side were apparently silenced; one on the Asiatic side continued firing. The damage was subsequently found to be comparatively small and many of the guns were still intact. Eight battleships were engaged with a total of 46 guns of major caliber, 30 being 12-inch, and 58 guns of minor caliber from 7.5-inch to 4-inch. The shore guns were ten 10.2-inch, six 9.2-inch, and two 6-inch. No ship was hit. In general the guns were mounted in open works near the old masonry castles, with the sea faces protected by earth.

Action against these forts continued until February 25, when the reduction of all four was completed. In the meantime the new battleship, the *Queen Elizabeth*, with eight 15-inch guns and twelve 6-inch guns, had arrived, giving the allies 16 armored ships of the line, 12 British and 4 French. The British casualties had been three killed and five wounded. Landing parties had been sent ashore as quickly as possible to complete the work of destruction, but were driven back by the Turks before completing the job. It was reported by the British that all forts were completely demolished with the exception of one at Kum Kale.

OPERATIONS AGAINST THE FORTS AT THE NARROWS

Sweeping operations to clear the channel of mines and obstructions began February 25, and on March 1 three ships entered the strait and attacked Fort Dardanes with its five 6-inch guns in rectangular turrets on the military crest of a hill 350 feet high; these were said to be the only Turkish guns with telescopic sights. Sweeping operations and the attack on Fort Dardanes with its outlying smaller batteries continued until March 5, the French division and the *Queen Elizabeth* using indirect fire from the Gulf of Saros on the forts at Kilid Bahr at the Narrows. An aeroplane ship with sea planes and aeroplanes accompanied the fleet. But not a shot hit the forts during the indirect bombardment; according to the Turks, the aeroplanes did not remain long enough in the air to direct the fire. On March 8 the *Queen Elizabeth* entered the strait and fired on Kilid Bahr at 21,000 yards range. This long-range bombardment of the forts at the Narrows and closer action by the other ships against the batteries south of the Narrows, together with mine sweeping, continued until March 18. The ships were hit several times, including the *Queen Elizabeth*, which was struck by field guns, but no material damage was done and the casualties were slight. Fort Dardanes and other concealed batteries near by were almost daily under the fire of from four or five ships, sixteen 12-inch guns and forty-eight 6-inch guns being used against five 6-inch guns. No battery on the Turkish side was put permanently out of action. The Turkish casualties, omitting those in the forts at the entrance, which were heavy, were 23 killed and 10 wounded.

FINAL ATTACK OF MARCH 18

On March 18 there was a general attack on the Narrows, participated in by 12 British and 4 French ships, mounting a total of 82 major caliber guns from 15-inch to 9.2-inch, and 178 minor caliber guns from 7.5-inch to 4-inch. As stated in paragraph 2, subparagraph 2, "Fortifications of the Dardanelles," pages 4 and 5, the number of guns that the Turks could bring into action against this fleet was 36 major caliber direct-fire guns and 21 howitzers, a total of 57, and 37 minor caliber guns. In addition there were fieldpieces and movable heavy howitzers, the number being indeterminate. In the forenoon the *Queen Elizabeth*, just inside the entrance, 10½ miles from the Narrows, and three older British ships bombarded the forts at the Narrows, while two other British ships at closer range attacked Dardanes and the batteries south of the Narrows. Shortly after noon the French division of four ships advanced to the support of these two ships, taking up a position near Kephez Point, 3 miles south of the Narrows. A heavy fire was now returned by the forts, but as the ships were maneuvering in circles, few hits were made. The 10 ships that were engaged at this time mounted 58 major caliber guns. At 1:25 P. M. the forts ceased firing. A fresh British squadron of six ships now arrived to relieve a corresponding number of ships well within the strait. As this squadron neared Kephez Point, the other ships turned to withdraw when the French ship, *Bouvet*, was struck several times and blew up, the cause of the explosion probably being a drifting mine. The new squadron continued the advance, attacking in line; the ships just within the entrance continued the bombardment, but it was manifest that the forts had not been silenced. Mine sweeping operations continued, but drifting mines sunk the British ships *Irresistible* and *Ocean*, and a mine and gunfire so badly damaged the *Inflexible* that it with difficulty reached the harbor of Mudros, 40 miles away. The French ship *Gaulois* was also badly damaged by gunfire. The attack ceased when darkness fell.

The attack had been badly repulsed and was not again renewed. The British casualties were slight, 61 all told, practically all the crew from the *Irresistible* and *Ocean* being saved; but the French lost nearly the entire crew of the *Bouvet*. The Turks lost 23 killed and 60 wounded. The 6-inch guns in the turrets at Dardanes, which had received such a heavy fire, were not damaged; the turrets were hit only three times. On the European side three 10-inch guns were put out of action, but three weeks later all were ready again. The stone barracks in rear of the batteries were destroyed; 86 shells fell in a space 300 feet deep in rear of one battery, but the battery was untouched. The shells easily penetrated earth, but not one passed through sand parapets. After March 18, the Turks substituted sand for earth to a large degree in the parapets and divided up the large interior rooms of the batteries into smaller ones by hollow walls filled with sand.

EFFICIENCY OF SEACOAST FORTIFICATIONS

The operations in the Dardanelles have been the only instance in this war of a naval attack on seacoast fortifications, except the minor attack of the Japanese Navy against the German fortifications at Tsingtau. Elsewhere, by virtue of their existence, they have performed their functions of protecting harbors, fleets, and naval bases. The German fleet, under the protection of the shore guns, has maintained its existence in spite of the proximity of the superior British fleet.

These operations have emphasized the fact that has been thoroughly demonstrated by history that a purely naval attack can not succeed against seacoast fortifications adequately armed and manned, and that in such actions the proper function of the navy is to convoy the army, which will make the attack by land, and to protect its line of communications.

REQUISITES FOR SUCCESSFUL DEFENSE

The forts at the entrance fell and those in the Narrows were scarcely damaged, though in both cases there was an overwhelming fire from the ships. The difference in the two cases is this: At the entrance the guns were outranged and the ships had plenty of sea room in which to maneuver and bring the heavy guns to bear, free from danger of mines; in the narrow mined channel of the Narrows, with both shores lined with guns, some of them equal or nearly so to the heaviest ship gun, the ships had to come within range and could attack with only a portion of the force. In such a position, a fleet, exposed to fixed and floating mines, shore torpedoes and submarines, will fail. The slight damage sustained by the shore batteries is illustrated by Fort Dardanes, which withstood the fire from the British ships, admittedly inferior to none in marksmanship. An interior city, with its approach channel protected with well-placed and concealed guns, equal in range to the enemy's, and provided with the accessory means of defense, need not fear capture by bombardment or a run-by the forts. A fort on the seacoast proper, exposed to the fire from ships at sea, must have guns of greater range than the ships' guns; otherwise the ships could silence the guns on shore at their pleasure, and under their fire could land troops to complete the destruction of the forts.

Concealment and dispersion are also necessary. The aeroplane observation of fire by the allies does not seem to have been very efficient, but this can not always be relied on, and concealment from aerial observation should be obtained. Without such observation, long-range indirect bombardment is worthless. By taking advantage of the terrain and resorting to dispersion, the amount of concrete might be reduced, and the money thus saved put into more guns.

NECESSITY FOR MOBILE TROOPS

The power of coast fortifications, to repel a direct attack by an enemy fleet, is limited to the area within range of their guns, but their influence is extended considerably further whenever they cover a base from which submarines operate. These fortifications must therefore be recognized as of supreme importance within the scope of their proper functions, and this is especially true of a country possessing an enormous frontage on two oceans. Their paramount value is that they relieve the navy of the local defense of important harbors or other strategic points and thus release our seagoing fleet for operations against the enemy on the high seas, and furnish a refuge for it in the face of overpowering odds. But beyond the sphere of influence of our seacoast forts, enemy ships may approach the shore with impunity and, under the cover of their guns, may land troops that can then proceed against the important places defended by the forts or even against the forts themselves, since they are vulnerable from the land side. With our long coast lines, the guarding of every possible landing place by seacoast fortifications is out of the question, and, although the development and employment of heavy mobile seacoast armament along our coastal

railroads will further restrict the landing places open to an enemy, there will still remain many places affording facilities for landing operations which can only be opposed by mobile troops acting without the co-operation of Coast Artillery. For these reasons it is evident that there must also be available a mobile force properly trained, organized and equipped, to send against the enemy at the landing and defeat them there, or at least prevent his advance toward his objective, should a landing be effected. Until we have adequately provided for this dual defense of our coasts, having full regard to both fixed defenses and mobile troops, our Navy will never be free to perform its primary function, but will be frittered away in response to clamor for protection from our coast population.

An illustration of the value of mobile troops in coast defense is afforded by the operations at the Dardanelles, described in the last subhead under paragraph 3, page [352], of this study.

3. Summary of Attempt to Take Dardanelles Fortifications by Mobile Troops

INITIAL DELAY

Before the attack of March 18, it had been decided to undertake operations by land at the Dardanelles. An official French note stated on the 12th that a force was on its way to the Levant, and Gen. Ian Hamilton was appointed commander of the British force and arrived in time to witness the action of the 18th. Both the French and British forces had arrived in the harbor of Mudros on the island of Lemnos, west of the Dardanelles; but as the British transports had not been loaded with a view to making a landing in force on a hostile shore and as the lack of facilities in Mudros made redistribution impossible there, they had to be sent back to Alexandria for reloading. A month was lost, which it is safe to say was well employed by the Turks.

TERRAIN

The Gallipoli Peninsula is covered by hills which rise to a height of 1000 feet; on the southern end Achi Baba, 600 feet high, dominates the end of the peninsula; just west of the Narrows, Kilid Bahr, 700 feet high, covers the forts from an attack from the Aegean; and northwest of the Narrows, Sari Bair Mountain reaches a height of 970 feet. These hills must be taken before an advance can be made to the shores of the Narrows. The hills do not run in a regular or well-defined direction, and between the hills there are a confusing number of valleys. The area is practically roadless and most of it covered with prickly scrub. The sides of the hills are almost vertical. At the water's edge there is generally a narrow beach with a steep bank 10 feet high, and then the rolling hills with their crests 1000 yards from the beach. Every trail leading to the beach was covered with one or more machine guns in screened pits, and the roads were covered with field guns in groups of from three to six.

STRENGTH OF FORCES

The British force consisted of the Twenty-ninth (Regular) Division, the East Lancashire (Territorial) Division, a naval division of bluejackets and marines, some Indian troops, and the Australian and New Zealand Corps, with 20 battalions of infantry, together with artillery and engineers.

The strength was approximately 100,000. The territorials and colonial troops had been wintering in Egypt. The French force was about 35,000. The Turks were in greater force and better posted than was expected; the number on the European side has been given as over 150,000. Besides, they were supported by the Germans.

ALLIES' PLAN

The coast being precipitous, landing places few, and trenches and entanglements being visible on shipboard at most of them, Gen. Hamilton decided to throw the whole of his troops very rapidly ashore at a number of places, and selected five beaches at the tip of the peninsula and two on the west coast, near Sari Bair Mountain, as landing places. He could thus advance up the peninsula or cross it where it was about five miles wide, and obtaining possession of the high hills, secure observation points whereby the navy could assist in the reduction of the forts.

LANDINGS AT SOUTH END OF PENINSULA

April 25 was the date of the landing. The Twenty-ninth Division, 20,000 men, was to land at the end of the peninsula at the five beaches, the three at the tip, near Sedd-el-Bahr, being the main ones. At the other two places, the landing was to take place at dawn, while at the main places the landings were to be simultaneously at 5:30 A. M., after half an hour's bombardment by the fleet. The landing parties, covering the advance of the division, were placed on naval vessels the previous day and before dawn on the 25th were in the small boats in which they were to be towed ashore. The accompanying squadron of four battleships and four cruisers began the preliminary bombardment. At S beach, in Morto Bay, the farthest to the east, three companies (750 men) made a successful landing, with a loss of 50 men, and kept the position. On Y beach, the westernmost landing, two battalions (2000 men) landed on an undefended beach, but were subsequently attacked and driven to the boats with heavy losses. On X beach, 3 miles south of Y beach, 1 battalion (1000 men) made a successful landing, under cover of the fire of the *Implacable*, which stood close inshore, firing with every possible gun, thus preparing the way for a subsequent force of 2000 men, which joined hands with the force landing at W beach, the next to the south. On W beach, 1 battalion (1000 men) landed on a beach 350 yards long and 15 to 40 yards wide, well protected with intrenchments and entanglements, the latter extending under water. The Turks reserved their fire until the first boatload of soldiers grounded, and under this fire the assailants had to make their way through the entanglement. A foothold was gained and, more infantry following, connection was made with X beach. At V beach, west of Sedd-el-Bahr, the site of the seacoast forts that had previously been reduced by the navy, a force of about 3000 attempted to land on a beach 350 yards long by 10 yards wide, overlooked by a natural amphitheater rising back from the beach, with concave slopes. On the very margin of the beach ran a wire entanglement and up the slopes were two other lines, the whole covered with fire of rifles, machine guns, and pom-poms. Three companies (750 men), landing in small boats, were almost annihilated, the survivors obtaining shelter under the lee of a low sandy bank 4 feet high, at the inner edge of the beach; the boat crews were all killed. It was intended to land 2000 men from a collier, the *Clyde*, which was to be run ashore, and lighters used to form a

gangway between ship and shore. The attempt failed; of 1000 men who left the colliers, 50 per cent were killed or wounded. Nothing could be done until night, when the remainder of the infantry from the *Clyde* went ashore. On the 26th, under cover of the fire from the ships, the troops established themselves on the crests of the surrounding hills. During the night of the 25th, the disembarkation of the remainder of the Twenty-ninth Division was proceeding on W and X beaches.

LANDING BY THE AUSTRALIAN-NEW ZEALAND CORPS

This corps of 35,000 men landed north of Gaba Tepe, near the foot of Sari Bair Mountain. This rugged and difficult part of the coast was chosen because it was believed it would be undefended. The landing was to be a surprise and the preliminary bombardment was omitted. The covering force of 4000 men in ships' boats was towed by destroyers to within 500 yards from the beach, which was 1000 yards long, when the destroyers dropped behind and steam launches towed the boats in. In the darkness the boats were close to the shore before they were discovered. About a battalion of Turks disputed the landing, but they were driven back. The main body came up in the transports and by 2 P. M. 12,000 men and two batteries of mountain artillery were ashore. The Turks promptly rallied and reinforced to 20,000 by 11 A. M., made counter attacks. These counter attacks continued for several days, but with the assistance of the ships' fire the British maintained their position. On this first day—April 25—29,000 men were landed.

DIVERSION BY THE FRENCH

As a diversion to draw the fire of the Asiatic guns from Sedd-el-Bahr, a regiment of the French corps landed at Kum Kale on the Asiatic shore on the 25th, but on the 26th they re-embarked, after a loss of 754, one-fourth of its effective strength, and the French corps began landing at V beach.

ATTEMPTS TO ADVANCE

On April 28 the allies held a line across the peninsula, three miles north of Sedd-el-Bahr, and an attempt was made to capture the hill of Achi Baba, which failed. The troops landing on the west coast also tried to advance, but were held to a semicircle 1100 yards in diameter from the beach. Here they were holding open a door to the vital point of the Turkish position and were keeping 24,000 of the best Turkish troops out of the main action around Sedd-el-Bahr. By May 5 the landing of the allies was completed. The British official report gives the losses among the British at this time as 602 officers and 13,377 men, which is about 13.5 per cent of the total estimated force of 100,000. It is estimated that the Turks lost 18,000 in the operations of April 25-27.

May 5 a general advance was attempted against the town of Krithia and the hill of Achi Baba, but the attack was unsuccessful. May 18 the Turks, estimated at 30,000, attacked the force at Anzac Cove (the name given to the landing place of the Australian-New Zealand Corps, themselves termed "Anzacs"), and were repulsed with a loss of 7000, the Anzacs losing 500. To May 31 the British losses were 38,636 (1722 being officers), the French about 5000, and the Turkish estimated at 60,000. The total battle losses of the British in the three years of the Boer War were 38,156. According to a Turkish report at this date the number of British and French

troops amounted to 90,000. The Turks had received 60,000 re-enforcements.

June 4 there was another general attack by the allies from Sedd-el-Bahr; on the right there were two French divisions, the rest of the line, 4000 yards, being held by 24,000 British infantry. The net result was a gain of 200 to 400 yards along a front of three miles. The line then held extended from south of Krithia southeast across the peninsula, about 4 miles from Sedd-el-Bahr. The appearance of German submarines caused the withdrawal to Mudros Harbor of the transports and the sending of supplies in small boats. The Turks under Enver Pasha made a general attack in the vicinity of Krithia June 30-July 2, but accomplished little, with a loss of 5150 killed and 15,000 wounded. To July 18, the British losses were 49,283, 2144 being officers.

LANDING AT SUVLA BAY AND SUBSEQUENT OPERATIONS

August 7 another landing was made at Suvla Bay, 4 miles north of Anzac Cove. The landing began at 2 A. M. on three beaches and by day a force of two divisions was firmly established. The Anzac force joined in the attack, the intention being to connect the two forces and capture the Sari Bair Ridge. The attack from Anzac was carried to the summit of the ridge, but as the Turks had been heavily re-enforced, the attack from Suvla Bay did not make the expected progress, and the line had to fall back. The two forces were finally joined on a line 12 miles long. The number of men landing at Suvla Bay is not known; the British speak of it as a fresh army and the Turks estimated it as 70,000. The British losses were heavy; according to the Turks, 30,000.

According to a German estimate, on August 30 the allies had from 20,000 to 25,000 troops at Sedd-el-Bahr, of whom 9000 were French, all that was left of the original 35,000; 9000 at Anzac Cove, and 70,000 at Suvla Bay. These numbers were not materially increased after that date, though the losses in the trench warfare since then had brought the casualties on November 9 to 106,610 among the British. The Turkish losses are unknown. On December 20 it was announced that the troops at Suvla Bay and Anzac Cove, about 100,000, had been withdrawn from the peninsula for service elsewhere; the troops at Sedd-el-Bahr were left there until January 9, 1916, when they, too, were withdrawn.

NECESSITY FOR HEAVY MOBILE GUNS

Although the Turks had ample warning of the impending attack, with an abundance of men to draw upon, and had guarded the most probable landing places with intrenchments and entanglements, the allies succeeded in getting ashore. With the limited number of beaches suitable for landing, the Turks apparently had sufficient force to guard every one; but some were overlooked and the success of the allies is due partly to that fact. The main reason for the success, though, is due to the fire of the covering ships, which could come in close enough to use all their guns and thus keep down the fire of the Turks. If the Turks had employed guns heavy enough to stand the ships off, the landing would not have taken place, for experience has shown that even the most powerful naval guns at long range are unable to put well concealed shore guns out of action. Even chance hits have little effect upon the sand or earthen parapets.

It may be accepted then as a fact, that to prevent a hostile force from landing there must be in addition to the usual infantry defense at all the

possible landings, guns of sufficient power to keep the naval vessels at such a distance that their secondary batteries can not be used. Thus the landing of troops or supplies from ships at so great a distance from the shore can readily be prevented by the infantry and field guns.

In the case of a landing on our coast, the stretch to be covered is so long that it is impracticable to implace in prepared positions enough of these guns to cover all the possible landing places. It will therefore be necessary to use mobile guns that can be quickly transported to the point threatened. The quickest method of transportation appears to be a railroad paralleling the beach, from which spurs could be run to points near enough to the front to keep ships at about 8000 yards from the shore. The railroad, spur tracks, and gun locations should be prepared in time of peace.

THE VALUE OF MOBILE TROOPS IN COAST DEFENSE

After the allies had succeeded in the landing operations and had assembled on the peninsula the entire expeditionary force, their further advance was small, and after maintaining a position near the water's edge for over nine months, the force was withdrawn. The reason for the failure appears to be threefold: First, the size of the Turkish force was underestimated and an insufficient number of troops was sent at first, and these troops were not sufficiently reinforced; second, the terrain was favorable to the Turks; third, most important of all, the Turks had sufficient troops to prevent the allies from advancing.

Considering our own requirements, it should be noted that the terrain along our Atlantic Coast is not so favorable to the defense as that of the Gallipoli Peninsula, as the landing beaches are numerous and extensive and the ground in rear is generally favorable for an advance. Moreover, our coast is too extended to permit the preparation of defenses in advance at all possible landing places. There is consequently the more necessity for mobile troops.

With a well-trained and equipped force equal or superior to the force that had succeeded in landing, the operations on the Gallipoli Peninsula lead us to believe that an advance from the beach away from the cover of the ships, can be prevented; but without such a force, once the outer line of defense at the beach has been penetrated, the forces must be withdrawn to some thoroughly prepared position covering the objective of the enemy. Unless such a position of suitable extent has been prepared in advance, further resistance is hopeless.

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STUDY ON THE DEVELOPMENT OF LARGE CALIBER, MOBILE ARTILLERY, AND MACHINE GUNS IN THE PRESENT EUROPEAN WAR

Prepared by the War College Division, General Staff Corps as a Supplement to the Statement of a Proper Military Policy for the United States

ARTILLERY

At the outbreak of the present European war two schools of artillery thought had gradually developed among the European nations. One school, fostered by the French, believed in the low-power, rapid-fire field gun of

about 3-inch caliber, and contended that with a reasonable supply of ammunition it was possible to render heavy field or siege artillery powerless with such a gun; the second school, headed by the Germans, although believing in the low-power, small-caliber, rapid-fire fieldpiece, believed that they must be re-enforced by a considerable number of heavier howitzers or field guns, which were to be used to combat the ordinary fieldpieces as well as such entrenchments as could be constructed by armies in the field and for long-range firing when necessary.

In general, Germany and Austria were the only European countries that had developed efficient large-caliber mobile artillery at the outbreak of the present European war, but this war has developed the use of the large-caliber artillery by all of the belligerent countries. This development of heavy mobile artillery in Germany, Austria, and France is shown in attached "Notes on Development of Large-Caliber Mobile·Artillery."

How the thoughts of the majority of the field-artillery officers influenced the artillery organization of France and Germany is best shown by their army organization as it existed at the outbreak of war, as shown by the following table:

Country	Number of 3-inch field guns per 1000 rifles	Number of light field howitzers per 1000 rifles	Number of heavy field howitzers per 1000 rifles	Total
France........	4.66	----	0.206	4.87
Germany......	4.12	1.37	0.61	6.1

This table shows that at the outbreak of war Germany had about one-half of a light field gun (about 3-inch) less than France per 1000 combatants. Germany, on the other hand, had 1.37 light field howitzers per 1000 combatants more than France had, and had 3 heavy field howitzers of about 6-inch caliber for every 1 possessed by France.

The proportion of heavy field howitzers was in reality much more than the table indicates, for, as is well known, France only had a total of twenty-four 4-gun batteries of 6-inch howitzers when the war opened, whereas Germany had more than one hundred and ninety 4-gun batteries of 6-inch howitzers.

We may say that the results of the war have justified not the French but the German organization, and that as a result the French have taken up the German idea and are now doing, and have been doing for many months past, everything they can to meet the German preparedness in heavy field artillery material by equipping their army with heavy field guns and howitzers. It is of interest to note that the French 6-inch howitzer had a maximum range of about 6600 yards, whereas the corresponding German gun, although older in years, had a maximum range of 7700 yards. In other words, the French were not only outclassed in number but also in the power of the individual gun.

In addition to this 16-centimeter (6-inch) howitzer, which was assigned at the rate of 4 batteries of 4 guns each to each army corps, Germany had a certain number of heavy gun batteries of 10-centimeter (3.94-inch) and 13-centimeter (5.12-inch) caliber and a field 28-centimeter (11.3-inch) mortar battery. The exact number of these batteries is unknown.

The successes of the German army for the first four months of the

war can be attributed, in a great measure, to the heavy field artillery with which they were equipped, and to its proper handling. Our observers all state that the moral actual effect produced on the French in the opening battles of the war by the heavy German field artillery was tremendous, and came to most of the Frenchmen, who had been taught and had believed that the 75-millimeter gun was the ruler of the artillery world, as a terrific shock. At the commencement of the war the French did not take the trouble to entrench nor conceal their artillery the way they do now; the result was that the heavy German batteries, when used as counterbatteries and assisted by aeroplanes, had a clear field and managed to destroy whole battalions of the light 75-millimeter French guns without the latter being able to do them any harm. After the opening battles of the war the French realized that they must have heavy field artillery, and made every effort to obtain it as soon as possible. The result was that between August, 1914, and March, 1915, they had sent a number of 4-gun batteries of 10.5-centimeter guns to the front and had adopted and issued to the service a considerable number of new 15-centimeter rapid-fire howitzers, and had started to construct 14-inch mortars. In other words, a few months after the war started the French school of artillery thought had completely veered around and adopted the German artillery idea.

From the artillery point of view, the lesson to be learned from the war is the same lesson that has been taught by every war since the discovery of cannon, namely, that everything being equal, the side having the heaviest gun and the best ammunition-supply system is the one that is best able to give the proper support to its infantry, and therefore has the greatest chance of success.

Before the present war started most of our artillery officers believed that the heaviest field gun or howitzer which would be needed by an army was the 6-inch howitzer firing a 120-pound projectile, and in justice to them it must be stated that, with the exception of the German and Austrian Armies, this belief was general. They also believed that the function of the heavy field guns of more than 6-inch caliber, which it was known Germany and Austria possessed, was to destroy field forts of steel and concrete, and that it would not be possible to transport either of these guns or the ammunition they required with the field armies. How wrong this assumption was is shown by the present war in which the Germans and Austrians have actually trensported with their field armies 11-inch howitzers, 12-inch howitzers, 16-inch howitzers, and 17.7-inch howitzers and used them, not for the purpose of destroying works of steel and concrete, but for the purpose of destroying field fortifications, supply depots in rear of the line, villages in which troops are quartered, wire entanglements and other obstacles. All reports now indicate that the great successes obtained by the German and Austrian Armies on the eastern front were due in no small measure to the use of these enormous fieldpieces, which must hereafter be considered as essential to success in war.

The lesson to be learned as to the amount of artillery to be assigned to the different units has been taken advantage of by the General Staff, who, in the organization recommended in their military policy, have increased the number of Field Artillery regiments with each Infantry division from two to three, and in the report of a board of officers which recently recommended that the heavy field artillery with each field army be increased

from one to three regiments. These recommendations, if carried into effect, will result in the following proportion of guns per 1000 combatants:

Country	Field gun	Light field howitzer	Heavy field gun and howitzer	Total
United States	2.70	1.35	1.12	5.17
Germany	4.12	1.37	0.61	6.10

The percentage of guns provided by Germany for her army is shown above for the purpose of comparison. It shows that before the war Germany had 1.42 more field guns per thousand combatants, about the same number of light field howitzers, and 0.51 of a heavy field gun less than we now contemplate. The number of heavy field guns given in the above table for Germany does not include any guns heavier than the 16 centimeter (6-inch howitzer), whereas for us it included the heavier contemplated fieldpieces. The proposed contemplated scheme for procuring enough guns, ammunition, and other necessary field artillery material to equip 1,000,000 men will involve the expenditure of about $470,000,000 over a period of 8 years, and, when completed, will only provide for about twice the number of guns used by Marshal Mackensen's army in the Galician campaign. In other words, if the scheme is approved by Congress, in eight years from now we will have about enough guns and ammunition and other necessary stores to supply two German field armies.

Artillery Ammunition

Before the present war no one ever dreamed of the amount of ammunition that would be required to keep the armies supplied, and if he did dream of it he kept his dream to himself for fear of being called crazy. It was known that at the beginning of the war both France and Germany had a reserve supply of small-caliber field-gun ammunition of about 2500 rounds per gun, and a corresponding amount for the larger fieldpieces on hand, and were splendidly equipped with facilities for manufacturing ammunition of all kinds in large quantities. Notwithstanding their reserve supply, which was considered immense at that time, and their facilities of manufacture, both these nations found themselves confronted with a most serious shortage of ammunition before the war had been going on very long, and in the case of France at least forced her to practically suspend operations for a protracted period.

At the present time the reserve supply of ammunition to be kept on hand per gun is considered as that necessary to wear out the gun; in other words, during peace a sufficient amount of ammunition should be accumulated for each gun to permit it to fire as long as it is capable of doing so. For a 3-inch field gun this amounts to about 5000 rounds per gun.

The question of ammunition supply has become such an important one that France and England have both placed cabinet ministers in charge of it; and England, so far as we know, has not solved the problem to date.

Aero Service for Field Artillery

Aeroplanes are now recognized as indispensable adjuncts of the Field Artillery. The following will illustrate some of the service performed by the Aviation Corps:

1. General reconnaissance work.
2. To discover exposed batteries of the enemy.
3. To test concealment of their own batteries.
4. To direct artillery fire on enemy's batteries and trenches.

Observation captive balloons are employed, as shown by the following report:

"The officers who conduct the fire of these guns are well up in the trenches, connected with their guns or batteries by telephone wires, which are usually run along the walls of the communication trenches and held in place by staples. In one second-line trench I counted 11 different telephone wires running out to different observation trenches. In addition to the observation posts in the advance trenches there is another method employed by both sides during the day; it is the *Drachen*, or sausage-shaped captive balloon which is sent up at daylight and remains all day until dark, at altitudes varying, I should estimate, from four to eight hundred yards, and far enough in rear of the lines to escape artillery fire, if directed against it. The observer in this balloon is equipped with telephonic communication and powerful glasses. This silent sentinel remains up rain or shine, and both sides have the greatest respect for its power of observation. We were not allowed to assemble in groups in view of them at the front.

"These observers are on the alert at all times, and we were informed that where groups of 5 or 10 appeared in the open, a shell was usually sent in their direction as a warning that nothing escaped their observation. These balloons are so generally used by both sides that during a clear day they can be seen up and down the lines as far as the eye can reach. I counted eight along the front—Notre Dame de Lorette—St. Eloi. They are used also, I was informed, very often in directing the fire of heavy artillery. The steadiness of this shape of balloon, even in a strong wind, is quite remarkable."

The War College Division has not made recommendation as to aviation equipment needed, as tests are now being made under direction of the Field Artillery Board at Fort Sill, Okla.

Conclusion

In general, the opinion of foreign officers and all of our observers abroad is that the *largest* calibers are the most effective and have done the work in this war with high-explosive shell.

The large-caliber howitzers and mortars with high-explosive shells are employed not only to reduce concrete forts, but are generally used now against fieldworks and entrenchments of all kinds.

Every effort should be made to provide our army with large-caliber mobile artillery and ample aero equipment.

Machine Guns

Machine guns have played a most important part in the present war, and have been extensively used by all sides, under all conditions, and have proven their worth.

The following table shows the number of machine guns per 1000 men of Infantry or Cavalry provided for by the organizations of the European armies at the opening of the war, and also the proposed proportion contemplated for our Army in the tables of organization:

	Army Corps		Infantry Division		Reserve Infantry Division		Cavalry Division
	Infantry	Cavalry	Infantry	Cavalry	Infantry	Cavalry	Cavalry
Germany	2	-------	2	-------	2	-------	1.67
France	2	2.2	2	-------	1.32	2.2	1.67
Russia	2	-------	2	-------	-------	-------	2.20
United States	-------	-------	2.12	3.24	-------	-------	3.24

Since the war started it is positively known that all the warring nations have greatly increased the number of machine guns with their armies. Exactly what this increase has been is, however, unknown. Reports received from our observers indicate that there is about one machine gun for every 30 yards on the western front. At the commencement of the war the Germans had 64 and the French 66 guns per army corps.

CONCLUSION

It is believed that machine guns at the rate of 6 per battalion of Infantry or squadron of Cavalry should be provided for our Army, or 18 machine guns per regiment of Infantry.

Notes on Development of Large-Caliber Mobile Artillery in European War

GERMANY

The Germans had 42-centimeter (16.5-inch) mortars, 28-centimeter (11.023-inch) Krupp siege howitzers, and 21-centimeter (8.4-inch) howitzers at the outbreak of war. These mortars and howitzers were employed in the reduction of the Belgian fortifications.

The *42-centimeter (16.5-inch) mortars* are transported by rail, and spur tracks are run directly to the edge of the pits in which they are emplaced. It is probable that a derrick car is used to mount the parts of the carriage and the mortar and also to handle the shell, which weighs about 2000 pounds.

In the recent German-Austrian offensive in Galicia, May 2 to June 25, 1915, large-caliber howitzers and mortars were used with marked success against field intrenchments and field works.

"In addition to the regulation quota of artillery pertaining to the divisional organization, there was assigned to the army for the special mission a large quantity of heavy artillery, including certain 21-centimeter howitzers, 28-centimeter seacoast mortars, 30.5-centimeter mortar batteries, and probably some 42-centimeter mortars, as these were used later in the campaign at Przemysl. * * *

"The present war has shown that we must revise our views as to what constitutes 'field' artillery. With ordnance having calibers as large as 30.5 centimeters, moving steadily along with the troops, the artillery features of present-day combats have received a marked development. Thanks to this heavy ordnance, the German-Austrians were enabled to break down the material and moral resistance of the Russians at all their strongly prepared positions, and to prepare the way for assault of the infantry, which found its task relatively easy. At ——— the ——— had a ring trench about 200 feet in diameter on the summit of a low knoll forming a closed work about 250 yards in rear of a long rifle trench lower down a gentle

slope. Within this ring trench were seven craters made by 30.5-centimeter (12-inch) mortar shells, some of the craters intersecting and sections of the trench having been obliterated. At Hill ——— on the ——— position in front of ——— the Russians had a strong fieldwork consisting of a double tier of trenches with overhead cover, traverses and splinter proofs. This was assaulted and carried by a division after about two hours' artillery preparation by 21-centimeter (8.25-inch) howitzers and 30.5-centimeter (12-inch) mortars, with almost negligible losses. This work was inspected before the field had been cleared, and it was easy to understand how demoralized and shaken its defenders must have been in consequence of the effective artillery fire. About 100 corpses lay in or close to the trenches, most of them terribly mangled, even with clothes torn from the body by the blast which occasionally blew them out of the trenches on the ground in the rear. Whole sections of the parapet were obliterated and splinter proofs were wrecked. This work was built along the edge of a pine grove which was almost leveled to the ground by the artillery fire. Again at ———, the work on knoll ———, to the west of ———, a very strongly built fieldwork with strong, wide wire entanglements, was bombarded for an hour with heavy artillery with similar effects to those described above. The attack of field fortifications by 12-inch ordnance is a novel feature in war, but in no other way can the strongly built positions, which an enemy can build in a few days, be prepared for assault by infantry. The transport of such heavy field ordnance, and, more particularly of the needful ammunition supply, of course, presents tremendous difficulties, and, without fairly good roads, is impracticable * * *.

"During long trips, on four different days, over practically all the roads between the ——— and ———, military transportation of every kind, from the light, native country wagon, hauled by two diminutive horses, to the heavy motors, hauling 28- and 30.5-centimeter mortars, were encountered moving steadily to the front without any serious difficulties * * *.

"In their previously prepared positions, the ——— showed some fine examples of technical work, their fire trenches being invariably provided with overhead cover, and with plenty of splinter proofs close at hand. It was only because of their free use of the heaviest artillery that the German-Austrians were able to break the lines.

"The Germans have, on several occasions, fired 38-centimeter (15-inch) shells into ——— from a distance, it is estimated, of 30 kilometers (18.7 miles); where these shells have fallen they have caused great destruction."

The success of the 42-centimeter mortar and the excellent results secured from this weapon have steadily spurred the Krupp Co. on to developing even larger and better calibers of guns. It is claimed that the Krupp Co. has now perfected the 54-centimeter (21.26-inch) gun with a range of about 38 miles.

AUSTRIA

"The Austrian army infantry division had, at the outbreak of the war, about 42 field guns and howitzers per division of 12,000 rifles. This percentage is exclusive of the corps artillery which is composed of 8 heavy howitzers.

"As the war went on the number of batteries has been increased in various ways until there are now probably 50 field guns per division. The

corps artillery remains as at the beginning, but the field army artillery, composed of 24-, 30.5-, and 45-centimeter (17.7-inch) mortars, is being constantly increased and is used as field artillery.

"The Austrians are using their large guns up to 45 centimeter (17.7-inch) against fieldworks, field guns, storage depots, railway stations and villages, where troops are quartered, and to tear up barbed wire and other entanglements. These uses are made because the guns are available.

"The writer visited three forts of ——— shortly after the fortress was captured. The Germans had used 42-centimeter mortars to prepare the forts, but what part of the destruction of the concrete work was done by the German shells or what part by the ——— when they surrendered the fortress to the ——— is not known, but it may be stated that the moral effect of the bombardment was very great, for the ——— defense was weak when the infantry assault took place.

"The ——— had very few guns of position in ——— and the mobile artillery was reduced as much as possible to provide field artillery for the field army. In one artillery position were found two 8-centimeter field guns and a 5-inch gun stood on the road nearby, showing that it had been in use in the vicinity. In one of the forts there was a rapid-fire gun pedestal mount of 3-inch caliber. These were the only guns seen.

"The writer has seen the effect of fire of the 30.5-centimeter (12-inch) and 45-centimeter (17.7-inch) mortars on semipermanent earthworks. The craters on the hill in rear of the line of works were 20 feet deep and 30 feet in diameter, and the blast from the explosion of the shells must have been tremendous. The usual killing radius mentioned by ——— officers was 200 meters, but it is scarcely that great, but it is great enough to cause the ——— to have a profound respect for the "ammunition wagons," as the soldiers called them.

"Artillery fire is very effective when the target is suitable; for instance, enfilading artillery fire is feared. It is to be doubted whether the 3-inch gun produces the effect on moving lines in the open which might be expected; but the heavy shell fire from field howitzers is very effective as a morale destroying agent."

France

At the outbreak of war, the mobile artillery consisted of substantially the following calibers:

"65-millimeter (2.56-inch) mountain.
75-millimeter (2.92-inch) field guns.
155-millimeter (6.1-inch) rapid-fire Rimailho gun."

The following artillery, considered as obsolete at outbreak of war, was put in action as soon as possible after the superiority of the German heavy artillery was demonstrated:

"Old material:
120-millimeter (4.73-inch) long and short gun.
155-millimeter (6.107-inch) long and short gun.
220-millimeter (8.66-inch) mortar.
270-millimeter (10.66-inch) mortar."

About one month before the outbreak of war, 6 regiments of 105-millimeter (4.14-inch) guns were authorized, but the guns were not ready

for issue at the outbreak of the war. Since the outbreak of war these regiments have been furnished with the 105-millimeter (4.14-inch) guns, and the following other calibers have been introduced:

"150-millimeter (6-inch) Schneider rapid-fire howitzers.
260-millimeter (10.5-inch) howitzers.
305-millimeter (12-inch) navy gun, mounted on railway carriage.
340-millimeter (13.8-inch) navy gun, mounted on railway carriage.

"The French have been making a new 370-millimeter (14.6-inch) mortar. Six or eight have been completed and are to be sent into the field immediately. This piece was under study when the war broke out, and is comparatively simple in construction; the trials have given most satisfactory results."

The 75-millimeter field gun is now seldom used by the French in bombarding field entrenchments.

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FINDING YOUR WAY AT NIGHT WITHOUT A COMPASS*

(An Accomplishment Necessary for the Soldier, Explorer, or Traveler)

By Lieut.-Colonel W. A. Tilney, F. R. G. S., F. R. A. S.

With so much fighting now done at night, this art would appear to be most useful for soldiers to learn. The following is an account of its development and solution.

During the South African war I was often sent on long-distance night reconnaissances, and sometimes had Col. Benson, who led the attack at Magersfontein, as a companion. We noticed that the colonials, South Africans and natives were quite at home in the dark, whereas men from the British Isles were blind and helpless and lost their way when only a short distance from the column.

Col. Benson often told me about the attack at Magersfontein, and described the difficulties of a night attack when the operation depends on one man with a compass.

As an aeronaut in Ladysmith, I had plenty of opportunities of foreseeing the great power aeronautics would have in warfare in the future, and that most of the effective fighting would be done at night.

At that time the regulations described night operations as extremely hazardous, and warned the commander who undertook such operations that he did so at his own peril and was responsible for the results. Various expedients were suggested to enable the troops to keep their direction, such as that the route should be previously reconnoitered and marked by tins, pieces of paper and other devices; but how the reconnoitering party were to carry out this operation nobody has yet been able to understand. We found the colonials never required this artificial help, and could move about on a starlit night as easily as in daylight and as fast as the nature of the ground permitted, whereas our regulations laid it down that local guides should be procured, the route fixed by compass-bearing, and that the pace would rarely exceed two miles an hour.

With the whole operation dependent on the guide, and each individual

* A paper read before the Royal Society of Arts.

blind and helpless in the dark, it is little wonder that the regulations described a night attack as extremely hazardous. We foresaw if we only could devise some simple method for finding our way at night, which could be easily learned by the rank and file of the army, it would have a far-reaching influence on night warfare. In 1903, on my return to England, I took up the problem of "How to make a simple and practical use of the heavens," and ascertained from various colonials, Basutos, Indians, and Arabs that they could instinctively read the heavens as a compass, this knowledge having been transmitted from father to son for generations.

My idea was to work out the exact movement and direction of the largest and most easily distinguishable lights in the heavens, so that the least educated had only to be able to recognize these signs by sight and their whereabouts would be known for every hour of the night. Thus, the dome of the heavens would be a compass.

In 1904 I went through a six months' course at the Royal Geographical Society, under Mr. Reeves, in the hope that we should be able to work out the positions of these various heavenly bodies, but found that the only means of doing so was by observation with a sextant or other instrument and the help of logarithms, etc.

Each observation and calculation took at least twenty minutes, so that to have made a calendar of the heavens by observation was an absolute impossibility.

Some of the highest navigating authorities took a keen interest in the idea, and I am deeply indebted to Mr. Reeves, Captains Nansen, Scott, Armitage, Smith, and Blackburn for the help they gave me.

It was not until 1907 that we were able to get star bearings mechanically with the help of an orthographic projection of a sphere. Mr. Reeves's astronomical compass originated from this method. In 1909 Capt. Blackburn, nautical adviser to the New Zealand government, sent me his A B C tables, and I then commenced to make a time table of direction stars for use in India. We found when the true bearing of various first magnitude stars was known, that it made all the difference to night operations; unfortunately we could arouse little official interest in the project, for anything to do with astronomy was considered too complicated for the average soldier.

However, in 1911 Capt. Weatherhead, naval instructor, Royal Navy, brought out a little book, with a foreword by Sir Robert Ball, in which he drew attention to the system I was then endeavoring to perfect, and, having received satisfactory reports from various cavalry regiments, I had every hope that the system would be of the utmost value to the army, if we could only get it well known before the European war cloud had burst. In 1912 it was amply proved that troops could march with ease, rapidity, and precision on a starlit night, now that the largest stars were labeled in the heavens, and soldiers began to realize that the ability to make long-distance rapid night marches gave troops the power to strike an enemy from a distance, if necessary, across country, and that this system was an enormous improvement on old methods, especially in India and Egypt.

In June, 1913, being certain we were now on the straight rode to overcome most of the difficulties connected with night operations, I made the double journey from Sialkot to Quetta to lecture to the Staff College, where I knew they would give the system a thorough good testing. The heat across the Sind Desert at this time of the year is terrible, and many of my

friends warned me that such a journey at the hottest time of the year, with only four days' rest at Quetta, would tax the strongest constitution; but feeling sure that the great war was not far distant, and that in case of any trouble in India this new power to make rapid night marches *without the help of guide* would be of the utmost value, I made the journey.

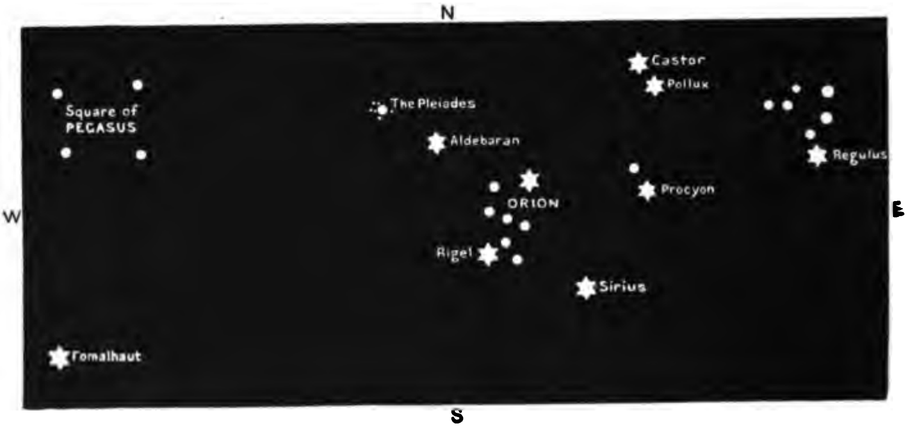

FIG. 1. 1819

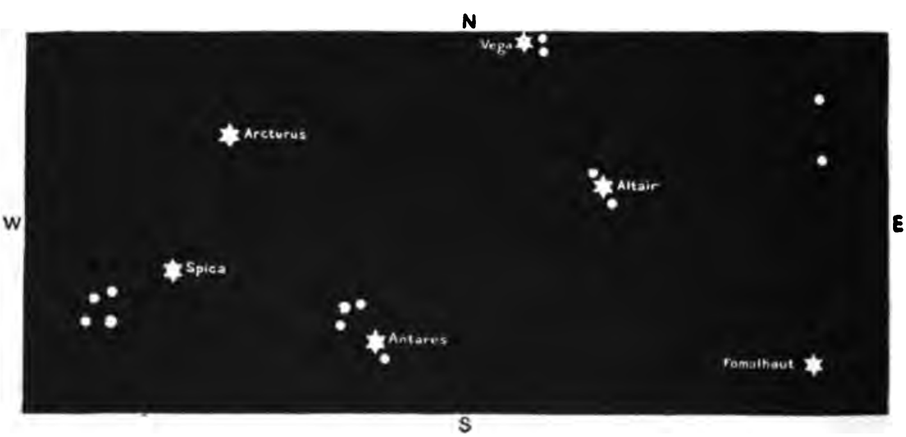

FIG. 2. 1820

Severe tests were carried out, and they reported: "We are perfectly certain that the system is a *most eminently sound one*," while the Indian Cavalry School reported: "The system has been tried at Saugor and has worked very well indeed. The students found no difficulty in determining the direction stars, and it is obvious that the faster the pace the truer is the direction." On my return to Sialkot, I realized that my friends' warning was true, and that unless I could get out of the heat I was done for. Fate decreed that I could not get home, and I almost died of heat stroke at Sialkot, so could not complete the tables for use in Europe till August, 1914, when Sir Douglas Haig wrote a foreword commending it to the notice of officers and men.

But it was too late, Armageddon had begun, and the work which I had hoped would be invaluable to the army in this crisis was of no avail. Many officers affirm it would have saved hundreds of lives and casualties had this natural method been known at the earlier stages of the war; so let us explain the system in a few words, and then see how it would have affected:

a. The individual in open and trench warfare.

b. Bodies of troops.

c. How rapid night marches can be conducted with ease, rapidity, and precision on a starlit night.

The System

Let us imagine fire balloons or beacons to be placed in the heavens north, east, south, west; it would then be easy enough to go in those directions. Similarly, if you wished to go, say, a hand's breadth, to the right or left of the beacons, you could easily do so. The stars mentioned in "Marching or Flying by Night Without a Compass" (published by Rees, 5 Regent Street, London, price 1*s*.) are the largest in the heavens and act as your fire balloons or beacons.

Now, if you put the front buttons of your coat on the North or other direction stars, your right and left breasts give you an angle of 45 degrees from the star and your shoulders a right angle. Also, it is only a matter of a little practice to be able to measure 15 degrees of horizon with your hand, so you can get any number of degrees to the right or left of your direction stars, and after a little practice it becomes second nature to recognize the points of the compass at sight, and you acquire the same sense of direction as bushmen, Arabs, and people who live far away from civilization.

The North Star, Altair, and Vega are all-sufficient night guides for the rank and file during the spring and summer. For autumn and winter, the North Star, the Sword and Belt of Orion, Procyon and Regulus.

Its Influence on Night Operations

At the present moment almost every individual from the British Isles is blind and helpless at night.

Let us remove this helplessness and we shall:

1. Give him confidence and self-reliance when engaged in night operations.
2. Give him a sense of direction, so that he will not fire or dig trenches in the wrong direction.
3. Be able to send individuals on messages, and all communications will be much facilitated.
4. Slightly wounded men will not wander toward the enemy's lines.
5. If we have to make an attack or retirement on a starlit night the whole brigade will know the line of attack or retirement, and so endless confusion will be obviated.
6. Similarly, in the attack every man will know what he is doing, and it will be possible to rally in any desired direction.
7. The stretcher-bearers will be able to go far afield and pick up the wounded.

Numerous other obvious advantages could be enumerated, for every man will be able to read the natural compass which has been in use ever

since the world began, and this knowledge is attainable without taking much trouble, simply by observing the heavens when out at night and expending 3*d*. on the "Soldier's Night Guide" (published by Gale & Polden, Aldershot), or 1*s*. on "Marching and Flying by Night" (Hugh Rees, 5 Regent Street, London).

FIG. 3. 1821

FIG. 4. 1822

FINDING YOUR WAY WITHOUT A MAP, COMPASS, WATCH, OR STAR TABLE

Let us suppose you are a private in the retirement from Mons, and after a hard day's fighting you bivouac in a field and fall fast asleep. You are suddenly aroused by the whiz of bullets and shells and are ordered to fall in. An officer says: "We have to retire five miles due south and

take up a position to cover the retirement of the ——— Brigade." Just as you are moving off a shell sweeps away the leading troops of the battalion, and by the time you are re-formed the advanced troops have disappeared. It is a pitch-black night with stars intermittently visible; between the clouds you see Vega, a very large bluish star with two little ones near it, making the letter V, almost half way down in the heavens, which give you roughly west, so you put your right shoulder on it and march south. Soon after you catch a glimpse of Altair, half-way down in the heavens, which gives you south-west, so if you go half left from Altair you will be going south. The troops around you have got badly knocked about, the country is rolling downs with occasional woods, and each time you have caught a glimpse of one of your direction stars you have taken some object to march on. You stop to help a pal who is badly hit, and as you look toward the north there is not a trace of the North Star or any northern constellation. You lay your pal in a cottage and then resume your journey. Vega and Altair are clouded over, you look eastward and see Aldebaran rising, which gives you east, so you put your left shoulder on it, take a point to march on, and pursue your journey until you come across a battalion entrenching themselves on the rise of a hill.

Finding Your Way to Trenches at Night

Although the system was only perfected in June, 1915, soldiers of all ranks have begun to realize the simplicity and wonderful utility of being able to read the universal compass, the heavens, and we begin to hear how useful this knowledge has been found for guiding supporting troops up to the first-line trenches, etc.

The heavens cannot go wrong, and on a starlit night you can rely absolutely upon them to take you to your destination, once you grasp the rudiments of the system; you only require to know three or four first magnitude stars, for their exact position is given for every hour of the night in "Marching or Flying by Night Without a Compass."

Let us see how it is done.

Say in Flanders on November 1 your battalion has to relieve another between 8 and 9 P. M. in an unknown line of trenches in a direction due east.

Look at the time-table of direction stars and you see the Pleiades (a large bunch of stars that nobody can mistake) is

$$\frac{85}{\text{E. f. N.}} \text{ at 8 P. M.}$$

$$\frac{95}{\text{E. f. N.}} \text{ at 9 P. M.}$$

Put this information in regimental orders, and when the battalion gets to the starting-point, the N.C.O.'s say to the men: "Do you see that ——— bunch of stars? The line of trenches we have to occupy is two miles from here in that direction; after you have gone one and a half miles you will come to a metalled road running north and south."

On arrival there the battalion will halt, close up and re-form. Every man then knows the line of advance, and on a starlit night they can move with ease, rapidity and accuracy.

Whatever direction you wish to go in, you will always find a convenient

guiding star for any hour or hours of the night. Naturally, if you want to send messengers to the rear, all they have to do is to put their back on the Pleiades and their right shoulder on the North Star (if visible) and they will be going back to the starting point due west.

That is not very difficult, and it has already been the means of saving many a man's life and getting troops out of difficulties.

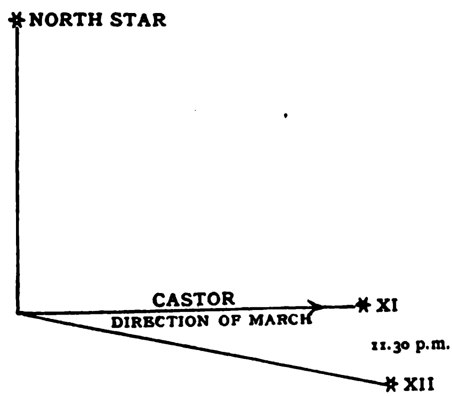

FIG. 5.

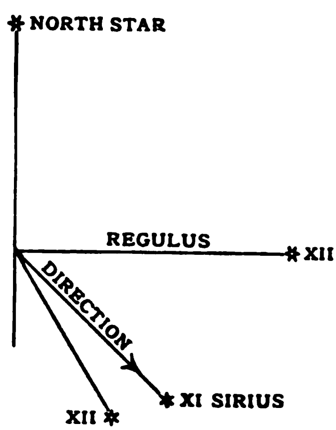

FIG. 6.

Now Let us Deal with Larger Bodies of Troops

Let us assume that the rank and file has been instructed in the art of finding their way at night and are now as night-perfect as any colonial, their fighting efficiency is increased 100 per cent, they are changed beings, and, like Basutos, are trained night fighters who can attack at night.

The great difficulty when large bodies of troops are making a converging attack is to keep direction, the whole advance being dependent on the guide or directing Staff officer.

Now, presuming all ranks can recognize their direction by a glance at the heavens, the Staff officers and leaders can proceed as fast as the ground

and conditions permit, with ease and accuracy, by plotting out the star-bearings.

The regulations say: "The most favorable conditions for night operations are a clear starlit night."

Example of a Converging Night Attack

Say in Lat. 50 N. on December 1 two columns, A and B, have to make a converging attack on a line of trenches one and a half miles from the position of deployment.

Column A, direction of advance due east.

Column B, direction of advance, southeast.

Time for moving off, 11 P. M.

The Staffs look up the respective guiding stars and ascertain, for Column A, Castor is due east at 11 P. M.

$$\frac{100}{\text{E. f. N.}} \text{ at 12.}$$

also Regulus due east at 12.

This information should be passed to all ranks, and to obtain great accuracy bearing-cards as follows may be plotted, but when stars are as convenient as the above there is really no necessity to plot.

Bearing-Card for Column A

Point the star-bearing line toward Castor and follow the direction line.

Bearing-Card for Column B

For column B, direction southeast.

Sirius is southeast at 11 P. M.

$$\frac{150}{\text{E. f. N.}} \text{ at 12.}$$

Of course, 45 degrees to the south of Castor and Regulus would also give southeast.

These should be plotted on a full-size card.

Several divisions who practised this form of attack under natural conditions had these bearing-cards lithographed off in the afternoon and distributed to the leaders, and it worked very well indeed.

The obvious advantages of attacking by star-bearings are:

1. All bodies of troops are moving on true bearings in the same direction and can move as fast as the ground permits.
2. All ranks know the direction and what they are doing. Their confidence and self-reliance is therefore increased.

Besides the advantages mentioned above, it has been found that distances, intervals, and communication can be easily kept up and the formations can be changed according to the nature of the ground. In short, most of the endless confusion connected with night operations is avoided.

Rapid Night March Across Country

I have purposely kept the example of a rapid night march till the last, as, except in such countries as Asia Minor, there is little scope in these days

of trench warfare for bringing this new power to strike an enemy at a distance into play.

Say, in Persia, Lat. 30 N., on September 15 (time-table of "Direction Stars for India"), a mounted column wishes to make a long-distance rapid night march, in order to surprise an enemy's encampment 25 miles distant.

Direction of march due west, country open and passable for all arms. There is only one road which goes through some hills to the north, and the enemy holds these positions in strong force.

On examining the map, a bee-line shows no very serious obstacle; but in order to check distances covered, and to ensure that the column is keeping an accurate direction, the following features are noted on an ordinary piece of paper in large black figuring, thus:

Distance	Feature
After going 2 miles	Stream
" " 4 "	Unmetaled road running northeast and southwest.
" " 5 "	Sugar-loaf hill.
" " 4 "	Small village.
" " 3 "	Strip of cultivated ground.
" " 5 "	Village at the foot of low line of hills.
23 miles	

The column halts, scouts are sent forward to ascertain the exact whereabouts and dispositions of the enemy.

On the reverse side of the card or piece of paper the following information is given.

GENERAL DIRECTION WEST.—DIRECTION STAR, VEGA

Time	Bearing
IX	$\frac{55}{\text{W. f. N.}}$
X	60
XI	60
XII	60
I	55
II	50
	W. f. N.

We will allow six hours for the 23-mile march, including halts (it was found in numerous test marches with mounted troops that 5 miles per hour could be comfortably covered over easy country); so, as Vega has set at 2 A. M., we must switch on to another star for the last hour. On looking at the time-table of direction stars, we see Fomalhaut is

$$\frac{135}{\text{W. f. N.}} \text{ at 3 A. M.}$$

so 45 degrees to the right of that star will give us due west.

Here are the bearing-lines for the march, but they are really not required when using such a constant star as Vega is in this case.

In all night work this power to read the heavens will be found to be extraordinarily useful, for if the body of troops has a guide you can see in a moment if he is taking you wrong.

Now someone will say to themselves: "What happens if the heavens become overcast while you are on this long night march? You will have to creep along at 2 miles per hour on compass bearings."

This difficulty has recently been overcome by the invention of the Ani-Pace Compass (Hugh Rees, 5 Regent Street, London), an instrument with no magnetic variation, gives true bearings, can be read by touch and sound, and once set is unaffected by oscillation. When any stars or heavenly bodies are visible it at once gives their true bearings and obviates the necessity to draw out the star-bearing and direction lines, as above described.

When no stars are visible, it enables you to proceed on true bearings as fast as the nature of the country permits.

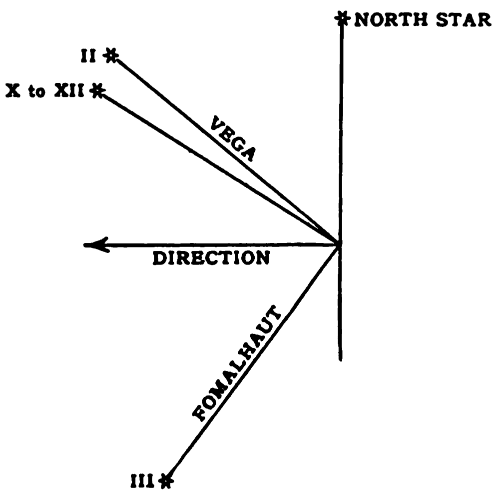

FIG. 7.

So we have conquered most of the difficulties connected with night operations and, as Sir Douglas Haig says, the method has been tested and found successful. Another well-known authority remarks: "The system is exceedingly useful because it is so simple, and is just what was wanted in the army when so much fighting is done at night; it will be of the greatest service to others besides soldiers."

If these predictions are fulfilled, and it proves to be a real service to the army in this great crisis, those who have helped to perfect the system will be more than well rewarded.—*Scientific American Supplement.*

THE ROUMANIAN ARMY

Since the Russo-Turkish War of 1877-78, when this army greatly distinguished itself, the Roumanian Army has continually increased; it is to-day the best equipped and best trained army after those of the Great

Powers. Whilst in 1877 the Roumanian Army only consisted of 80,000 men, Roumania can now easily put into the field 650,000 men, without including the 1916 and 1917 classes, which would be eventually called out. In 1913, during the last Balkan War, Roumania mobilized 550,000 men, 400,000 of whom invaded Bulgaria at the end of seven days' mobilization thanks to an excellent network of railways, and thanks to the services of its engineers and pontoon troops, who constructed a bridge over the Danube, about a mile and a half long, in six days.

The Roumanian Army now consists of five army corps, with their headquarters at Craiova, Bucharest, Galatz, Jassy, and Constantza. Each army corps consists of a reserve units command and two divisions. A division is composed of two infantry brigades, of two regiments each, an artillery brigade of two regiments, and a chasseur battalion.

The reserve units command consists of four infantry brigades of two regiments each and an artillery regiment.

In addition the following are attached to each army corps:—Two Red Hussar regiments, 2 Black Hussar regiments, 1 transport division, 1 light howitzer regiment, and 1 engineer battalion. The total amounts to 80 infantry regiments, 10 chasseur battalions, 10 Red Hussar regiments, 10 Black Hussar regiments, 5 transport divisions, 25 field artillery regiments, 5 light howitzer regiments, and 5 engineer battalions.

In addition there is a regiment of household cavalry, a heavy howitzer division, a mountain artillery division, a regiment of horse artillery, a fortress artillery regiment of 32 companies for the Bucharest fortified line, which has a circumference of 45 miles and contains 18 forts and 18 batteries, 3 fortress artillery battalions for the Focsanii—Namoloasa—Galatz fortified line, a fortress engineer battalion, a railway battalion, a pontoon battalion, and a specialist battalion (aviation, wireless telegraphy, motors).

The infantry regiment has three battalions of about 1000 men each and a machine-gun company. In the same way each cavalry regiment is provided with four machine-guns. The field artillery regiment consists of seven batteries, four of which are of normal, and two of reduced effective, and one depot battery.

The Roumanian infantry is armed with the magazine Mannlicher rifle and charger of five cartridges; the cavalry has the Mannlicher carbine, the sword, and the lance; the field artillery has the 77 mm. Krupp q.f. gun. The light howitzers, 105 mm., come from the Creusot works, as well as the heavy 155 mm. howitzers.

The infantry ammunition is made in the country. The works at Bucharest can turn out 1,000,000 cartridges a day. The artillery ammunition is made, in very small quantities, by the same works, the greater part of this ammunition coming from abroad. The machine-guns, about 400, are of Austrian manufacture.

The officers are excellent, thanks to the Roumanian military schools, which are organized on the model of the schools of the Great Powers. The training they receive is perfect. The Roumanian soldier is well disciplined, sober, and hardy.—From *Le Temps* in *United Service Magazine.*

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TRAINING OF RESERVE OFFICERS OF THE SWEDISH COAST ARTILLERY

By Captain GUSTAF WENNERSTROM

Translated from the Swedish for the JOURNAL U. S. ARTILLERY by Colonel JOHN A. LUNDEEN, U. S. Army, Retired.

In the law of 1914, relating to the army, the important change was made that reserve officers for the navy and coast artillery should be organized separately and that also, since there is not time to train these officers for both artillery and mine service, they are to begin their training as candidates for either artillery or mine service.

Hereafter those men who have had their first service of 458 days as conscripts and have taken the so-called "student examination" for the *artillery* and sea captain's examination for *mine* service, will be accepted as reserve officer candidates, provided they fulfill the other requirements.

The age limit is 24 years for the artillery and 27 for the mine service. The reason for this difference in age limit is the greater requirments in a sea captain's examination in the navigation schools.

Besides the above mentioned class of persons, corporals of the regular service can also be accepted as candidates, but this is more apt to apply to corporals of the mine service.

The applications are made to the Chief of Coast Artillery who acts upon them after the usual examination.

After being accepted, the candidate receives the rank of corporal and after a certain amount of training is promoted to the grade of noncommissioned officer of the first grade in the reserve. After a completed satisfactory training, the candidate is recommended by the Chief of Coast Artillery to the King for a commission as *ensign* in the Coast Artillery Reserve.

After having become an officer, it is necessary for the one assigned to the artillery service to take a "repetition" training of 45 days every third year until he becomes 45 years old. To be entitled to promotion to a captaincy he must take more training under special regulations.

For the mine service the conditions are somewhat different, since a sailor's business would be very seriously interfered with if he had to have a training period every third year. Therefore, in place of training every third year, a candidate appointed ensign shall immediately serve with the artillery mine service for one year, and, if this officer wishes to be promoted to a captaincy, he must take a repetition training of six months in one of the 6-10 years after his appointment as ensign.

On the recommendation of the Chief of Coast Artillery, an ensign is promoted sub-lieutenant who has served two years and has undergone satisfactory training, etc. For the *artillery service*, one is promoted from sub-lieutenant to lieutenant who, as an officer, has had 3 trainings; and from lieutenant to captain, one who as an officer has had 10 trainings. For the *mine service*, one is promoted from sub-lieutenant to lieutenant who has been an officer for at least 8 years; and from lieutenant to captain one who has been an officer at least 18 years and has had the prescribed trainings. Officers in the reserve must not be promoted before officers in the regular service who entered the same year.

A reserve officer *candidate* is entitled to receive while undergoing training, for the *artillery service* the same support and allowances that a conscript

has during his service and also 300 kr. (about $80.00) for clothing; for *mine service* 3½ kr. (94 cents) pay per day, 300 kr. for clothing, and for medical care as well as in certain cases an allowance for mess. He is also entitled to receive from the government stores certain articles to replace those worn out, and also necessary traveling expenses.

The reserve officer training for the *artillery service* is entitled, while in actual service, to the same pay and allowances as the regular artillery officer of the same grade: a captain in the reserve like a captain of the 2nd class, with the exception of an allowance for quarters.

For *mine service* the reserve officer receives the same pay and allowances as the regular officer of like grade and as his service lasts six months he also receives quarters or allowance for same. All officers receive 200 kr. (about $53.00) for clothing on being appointed ensign, and also necessary traveling allowances.

On attaining 45 years of age a reserve officer is discharged; and, if honorably discharged, he is entitled after attaining the age of 55, for the rest of his life, to a yearly pension of 300 kr. (about $80.00).

—*Svensk Kustartilleritidskrift.*

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LETTER FROM LIEUTENANT LIETZMANN ON BOARD THE *GNEISENAU* DURING THE FALKLAND ISLAND FIGHT

Translated from the German for the JOURNAL U. S. ARTILLERY by Captain SAMUEL G. SHARTLE, C. A. C.

Port Stanley, December 10, 1914.

Early in the morning the *Gneisenau* and *Nürnberg* arrived at the Falkland Islands, in order to confiscate provisions and government property. The other ships (*Scharnhorst*, *Leipzig*, and *Dresden*) remained behind the horizon. As we approached, we saw a cruiser with three funnels coming out. Behind the hills, smoke clouds were seen. Suddenly a 30.5-cm. projectile struck near us.

We withdrew and joined the squadron. We were making 21 sm. speed and desired to draw away with an easterly course gradually becoming a southerly one. Off obliquely from us eight hostile ships, of which only the smoke could be seen, were coming on. Gradually most of them fell astern. Only two did not fall behind, but approached slowly. Soon three-legged masts could be made out; hence they were English. They were making 26 sm., and they were large battle cruisers, which, we learned later, had arrived at the Falkland Islands only twelve hours before.

We were accordingly forced to fight. Because of the superiority, the small cruisers were detached. Of these, only the *Dresden* escaped. The enemy had begun to shoot at an unheard of range. "Clear ship for battle" was sounded. On deck, the boat lashings were loosened, and later all boats were destroyed by shell splinters.

The fight began at 12:30, and ceased at 5:30 with the sinking of the *Gneisenau*. The *Scharnhorst* sank at 4:00. We had only one-half of our ammunition on board, since the other half was shot away at Coronel and Tahiti.

The hostile ships were: *Canopus*, *Invincible*, *Inflexible*, *Carnarvon*, *Kent*, *Cornwall*, *Bristol*, and *Glasgow*.

After the *Scharnhorst* had sunk, all three hostile ships, the cruiser *Carnarvon* of our class and the two dreadnoughts *Invincible* and *Inflexible*, fired on us alone almost two hours with their heavy artillery (the small cruisers had been detached at the beginning of the fight). That they didn't destroy us sooner, is simply pitiable.

I estimate the full hits on our ship at twenty, not counting innumerable splinters. The *Inflexible* alone fired six hundred heavy projectiles; the number on the others, I do not know. We placed few hits on the *Inflexible;* twenty, however, on the *Invincible.*

The fight took place mostly at the range of 15,000 m. Almost during the whole fight, I was going through the ship, partly with the first officer and partly on duties assigned by him. The condition of particular places, I will describe later. It was indescribably frightful. We kept up the fight so long, that only seven charges of ammunition for the aft turrets remained. These could no longer be used, because the hoists were destroyed and all the guns on both sides were out of commission.

Then came the command: "All hands on deck with their hammocks." I had to see that each one got a hammock,—all this took place with the greatest calmness. I came up on the forecastle just at the time when the ship slowly, with majestic calm, turned over toward the starboard; I was able to jump overboard to port. I had thrown my pistol before this overboard, on account of the weight. I luckily came free of the ship, and saw how our old, beautiful *Gneisenau,* keel up, sank into the noisy waters. Two men still sat on the prow-post.

Owing to lack of ammunition, we had caused the ship, which could have still held out for a time, to sink by demolition of the engines and fully opening the torpedo broadside room, in order not to let it fall into the hands of the enemy. The top flag still flew; the aft flag had been shot away.

Our men worked as excellently, bravely, and calmly, as I had never considered possible. Before sinking, the Commandant gave three cheers for his Majesty the Emperor, in which all joined. Everything occurred with great calmness. Even in the water, many cheers could be heard. In the water, I saw Picht, wounded on the head, smilingly wave to me. I was able, with sailor Hirn, to reach a hammock with no owner.

The hostile ships came up, threw pieces of wood overboard and let boats down in spite of a rather heavy sea.

I was pretty far off to the side, but had the luck to be seen by a dingey and fished out. We were then lifted up on board and carried to the hospital. The Commander was drowned. I saw him at the last swimming near me; he was holding on to an empty cartridge box. I had swallowed much water and it was high time that we were saved, as our hammock began to sink.

On board the *Inflexible,* I lay, I believe, a long time unconscious, but was so clear-minded later that I could go and join at the mess. I live with the assistant steersman in a spacious room.

A telegram from the English Admiral on the *Invincible* was brought us, in which congratulations on their rescue to the survivors of the *Gneisenau* and high acknowledgement of their conduct in the fight were expressed. This esteem is shown us by every one of the English.

I cannot today write too much, because I am still dizzy. It is the same with the others. Tomorrow, we arrive at Port Stanley. What will become of us then, I don't know. At present, we are received by the English

officers very tactfully and kindly. One could not tell in any way that we are prisoners of war. We are taken good care of here on board. * * *

—From the Kiel *Neuesten Nachrichten* in *Der Seekrieg, 1914-15.*

NOTES FROM TSINGTAU

In the one case noted a shell had landed squarely between two 21-centimeter guns on a concrete emplacement covered with dirt, and penetrated three feet of dirt and seven feet of reinforced concrete, but the iron mesh used for reinforcing at the bottom of the bomb-proofing had bulged downwards without giving way. Fragments of the cement clung to the mesh so that from below it looked as though the ceiling had been dented in about six inches, as was indeed the case. Except for a few fragments of concrete, the chamber below was unharmed, though likely the concussion would have stunned, if not killed, occupants.

The German infantry trenches, as well as emplacements, magazines, and redoubts, were generally constructed of reinforced concrete, and relatively little damage was done to them. The infantry trenches suffered the most and were, in places, fairly well smashed up and the small bombproofs penetrated, but nowhere beyond recognition or repair. The small infantry bombproofs along the intrenchments sheltering about a squad of men and covered with dirt, were good protection against the three-inch shells as long as the dirt remained on top, but the larger guns with explosive (high) shell knocked down the roofing and probably killed any occupants. Nine-inch concrete walls and roofing was not heavy enough. From these results it is believed that concrete should be used only as revetment, walls, ceilings, etc., without expecting it to withstand any hammering after the dirt covering is blown off. Dirt should afford the protection, and the function of the concrete is to hold the dirt in place. A thick wall of concrete in infantry trenches is not justifiable. As far as fragmentation is concerned, some other substance like fiber would be preferable, or a covering of fine chicken wire should cover the concrete.

The rear interior walls of one of the coast defense emplacements was constructed of wood and plaster instead of concrete. Except in a few places it was not damaged by the bombardment or concussion. These walls are cheaper, and all that is required in the rear.

The sheltered communication roads at Tsingtau effectively concealed and protected the movements of troops. The important roads had a high bank of earth along the side towards the enemy except where they traversed deep cuts, which in themselves furnished excellent protection. Some of these cuts were through solid rock thirty feet high. The Germans had only one light battery, but on account of the good communications, and the protection they afforded, were able to use this battery in many positions, and lead the Japanese to believe that they had a regiment or at least a battalion of field artillery.

The permanent character of the barbed wire entanglements is quite noticeable. The wire is extra heavy, and on some of it the barbs come so closely together that it would be difficult to get a pair of pliers in a position to cut it. The stakes are galvanized angle iron with notches and a few holes cut in them for holding the wire. On the buried ends they have

iron shoes, square plates bolted on perpendicular to the stakes and about a foot square. The stakes are very heavy to remove, and were not bent unless struck squarely by shells. The attackers, breaking through, cut the wire, but could not clear the stakes. Even the coast defense batteries were provided with wire entanglements. For filling the break in entanglements at roads, a steel rack was constructed and strung with wire. This could be temporarily removed by the defenders when the road was to be used. A supply of these "porcupines" was also on hand to close any passages forced in the regular entanglements.

The German 28-centimeter howitzer has a steel dome covering, so that it has something the appearance of a telescope pointing through the dome of an observatory. This afforded fine protection against shrapnel and fragments. All the fixed guns in the forts which could be examined where the guns were 21 or 28-centimeter, had to be run back into battery after discharge by hand, there being a rack and pinion with a hand wheel for the purpose. All breechblocks were of the pattern which slide in through a slot cut perpendicular to the axis of the gun, in the breech reinforce. It is inferred from this that they were not quite up to date, though not obsolete. A covered passage led from the magazines to each howitzer. It is not certain whether this was used for loading the guns. If so, the crews would hardly be exposed at all in performing all their functions, as there was little space between this passage and the dome-shaped shield. However, the guns would have to be traversed to one place each time for loading.

At the commencement of hostilities it is reported that some guns were placed on board cars at Pekin or Tientsin, that bricks were packed around them, and that they were hurriedly shipped to Tsingtau invoiced as bricks.

The Germans had a large house or barn conspicuously painted white against the mountains at a certain known distance from the guns for a datum point. When the advance squads of the enemy appeared from behind the highlands at extreme range, the Germans were able to draw first blood, shooting with remarkable accuracy. All the trenches were stencilled with the ranges to conspicuous points in the field of fire.

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SIEGE OF TSINGTAU

(The Charge Against the Central Works at Tsingtau. Anonymous. *Kaikosha Kiji, Sept.*, 1915.)

After the beginning of the general attack on October 30, the Emperor's official birthday, the 56th Infantry, with the 2nd and 3rd battalions in the first line, had gradually advanced until on the night of November 5 they occupied a position within ten meters of the ditch of the works and were waiting for orders to charge. That night the engineers constructed two roads about five meters wide over which to advance. Upon recommendation of the commander of the 3rd battalion, transmitted through the regimental commander, the division commander ordered the charge, and it began at 1 A. M., resulting in the capture of the works. A second detachment followed closely, and securely held the position. Thereafter, the regiment, regardless of rifle and artillery fire, charged the batteries on Mount Bismarck and another mountain, and at daybreak completely occupied the position.

Preparations for the Charge

At about 7 P. M., [November] 6, 1914, the leader of the first charging party, Second-Lieut. Nakamura, received orders from Major Nakashima to report at battalion headquarters. He at once assembled his squad leaders and gave the following orders:

1. Uniform: Light order. Leave off knapsacks, put one day's ration of toasted bread in the packs, carry canteens and haversacks, wear as clean underclothes as possible, leave behind handbooks, diaries, etc., and all men will tie a white band around the left arm.
2. Arms and equipment: Rifles, bayonets, intrenching tools, and 210 rounds of ammunition per man.
3. I will carry a white flag, and each man will carry a national flag made during the time we have been confronting the position.

He then went to battalion headquarters, where he received instructions and all information at hand about the fort. A sergeant and 20 men from the engineers and 3 sergeants and 3 lance corporals especially selected from the 3d battalion, were attached. He was furnished with 30 hand grenades and a field signal lantern. He was also informed that our artillery would cease firing during the charge, but that it would open up on the enemy during pursuit; that an infantry squad and two bomb guns would provide protection from hostile positions to the north and west, and that the battalion and regiment would be in position ready to advance at the proper time.

He then returned to his platoon, gave instructions in handling the hand grenades and in the use of the signal lantern, and addressed them as follows:

"It is very essential, but most difficult, for military men to find a fit place in which to die. That we have been selected from the entire enveloping army to charge and capture the central position is a great honor, and, for military men, is a chance to die difficult to obtain a second time. Since our departure from Japan we, of course, have always had the resolution to do or die. It is considered a disgrace for military men to die of disease during a march or while besieged. Therefore we pay great attention to sanitation and avoid exposure to hostile eyes and guns, because we want as many bayonets as possible on occasions as this."

"Tonight I will offer my life to the Emperor. Life or death is ordered by Heaven and is beyond the power of man. To meet death composedly when it comes is the special characteristic of our country's warriors. This platoon must capture the central fort tonight, regardless of circumstances. Ground once captured must not be yielded even an inch. If I fall, the squad leader takes my place; if he falls, the lance corporal takes command; if he falls, all must co-operate and fight furiously even to the last man. Rifles will not be loaded, because as soon as we see the enemy, we must jump at him with our bayonets. As soon as we meet the hostile machine guns, the hand grenades will be thrown and we will charge just as they explode. The men carrying them will advance at the head of the platoon. Volunteers for this duty will report to me."

As one man, the entire platoon stepped forward. Ten were selected, and each one put three grenades in his outer pockets. Then the company commander, in a most serious voice, said: "If this detachment should fall

into desperate circumstances, I could never stand by and see it die alone, but would come to its aid with the remaining two platoons."

The battalion commander's address: "His Majesty looks upon the military as his right-hand men. Often since the beginning of this war he has sent his aide-de-camp to announce his gracious imperial will. This is the one stroke that will throw splendor on our flag, and, if you are brave and faithful, I do not doubt your splendid success under its divine protection."

Upon instructions from the company commander, they faced in the direction of the Imperial Palace, presented arms with fixed bayonets, and then marched off without uttering a sound.

At the position from which they were to charge, he assembled his non-commissioned officers and his two squads of engineers and gave the following orders:

"1. I command an infantry platoon and 2 squads of engineers, and I plan to charge the central fort at 1 A. M. tomorrow.

"2. An infantry patrol of 5 men with hand grenades, one squad of engineers, 2 scouts, and the 1st, 2d, and 3d infantry squads will form the right detachment, advancing by the right road. An infantry patrol of 5 men with hand grenades, one squad of engineers, one scout, and the 4th, 5th, and 6th infantry squads will form the left detachment and advance over the left road.

"3. The infantry patrols will advance with the engineers leading, and when the machine guns are met they will throw the grenades and charge.

"4. The engineers, as soon as the infantry occupies the fort, will dismantle all mechanical devices and turn them over to the infantry.

"5. The scouts will seek out and report the positions of the enemy, their outer defenses and mechanical devices.

"6. The remaining infantry will cross the ditch by means of ladders, one to each squad. Upon reaching the parapet, the right detachment will form line to the left, and the left detachment to the right, without interval between detachments.

"7. Lance Corporal Shima, as soon as the parapet is occupied by the platoon, will, facing the rear, make a signal to the right, left, up, and down, with the lantern. Then, if the parapet is successfully held, he will signal by waving the lantern in a circle. Before starting, he will connect up the electrical battery.

"8. I will be with the right detachment. Lance Corporals Okata and Yashima and 1st class Private Ikeda are detailed as orderlies."

Each leader was required to repeat his orders, and all watches were set. Promptly at 1 A. M., the ladders were lowered, the ditch crossed, and the detachments arrived under the enemy's parapet, of which Lance Corporal Shima was immediately informed by signal. Both detachments were about to form line, but everything was so quiet inside the fort that omitting to do so did not seem risky, and they proceeded in column formation towards the fort at right angles to the line of fire. They arrived at the gorge and occupied the shelter trenches there, stationed a patrol of one non-commissioned officer and ten men with hand grenades near the outside of the gorge to protect against counter attack and blocked all entrances to the enemy's bombproof shelter, which by this time they had discovered. Due to confusion among our detachments, our men's voices calling to each other were heard by the enemy outside the central positions, and they poured into

us a fearful rifle and machine-gun fire, especially on our right. The leader ordered a squad to charge the machine guns, which was done and the machine guns withdrew to cover.

During this time, the engineers had cut all telephone wires and located and forced their way into the telephone station. The enemy inside resisted with pistols, but our infantry overcame them with the butts of their rifles and stopped any further telephoning. All lights in the fort were extinguished.

About this time, the company commander came up with the two remaining platoons, stationing one at the gorge and sent the other into the bombproof shelter. The confusion of the enemy inside, clothed as they jumped out of bed, is difficult to describe. They immediately surrendered.

Under orders from the company commander the leader of the first charging party, Second-Lieut. Nakamura, then gave the necessary orders for receiving the surrender of the fort.

Later, we learned that the hostile sentinel had at first thought we were only a small patrol and learned his mistake too late.

—*The International Military Digest.*

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ON THE VALUE OF PERMANENT FORTIFICATIONS

Two articles are published in the first number of the *Kriegstechnische Zeitschrift*, 1915, which contain new ideas on fortification and attack. The first is by Frobenius, the other by an anonymous writer.

Frobenius writes: Military engineers should rejoice at the advent of the new very powerful siege artillery, the mortars of 30.5 and of 42 cm., because they know at length with certainty what kind of enemy they have to deal with, while in the past they were constrained to act in doubt. They have always felt suspended over their heads the sword of Damocles, representing the possibility of an entrance on the scene of the most powerful artillery. Now, however, they are able to measure the efficacy of a single shot of siege artillery, and since everything human has a limit it may be stated that the powers of artillery cannot be extended much further, so that the military engineer finds himself facing a well-defined problem.

The fortifications on the northern frontiers of France and Belgium may be subdivided into three groups: those which like Liège, Charlemont, Les Ayelles, Hirson, Longwy, etc., fell after a very short siege; others as Lille, Laon, La Fère, and Reims were evacuated on the advance of the German armies; while Namur, Maubeuge, Antwerp, were compelled to surrender in 10 or 12 days.

With regard to the first group it may confidently be affirmed that the non-success of the defense may be attributed to the superiority of the attacking artillery who succeeded in occupying the best positions from which they could bring to bear a most efficacious fire against well-defined and visible targets without being fired upon by artillery of equal power. As for the fortresses voluntarily evacuated it may be stated that had they attempted to resist they would have shared the same fate as the first, and it may be said with decision that the fall of Namur, Antwerp, and Maubeuge was essentially due to the attacking artillery. The author draws attention to the conduct of the French troops destined for the defense

of Verdun, Toul, Belfort, who showed great activity and took all possible advantage from the favorable conditions of the ground; causing every attempt of the enemy to fail. Those fortresses which became an easy prey to the attacking Germans were completely isolated, abandoned to themselves and by their garrisons. Verdun, Toul, Belfort, on the contrary, were not only defended by their own guards, but were validly sustained by the field army.

The author proceeds: If we desire to be just, from what modern warfare has shown up to now, it may be deduced that a permanent defensive organization is not only useful but necessary. It may also be remarked that besides Verdun, Toul, and Belfort, the part represented by the strong forts of Paris have in an indirect manner enabled the supreme French command to drive the Germans from the Marne. Of the value in the strategical field of Przemysl, Cracow, Königsberg how much is unknown? The fortresses are and always were indispensable, but they ought to be suitably organized to resist the more powerful means of offense. How may this be possible? By satisfying these two conditions: To locate the works so as to hold the enemy at a distance; and by constructing the same works so as not to render them easy targets. The first may be provided by two methods, that is by the most active offensive action of the garrison, and by arming the forts with artillery of great caliber.

Whilst, up to now, it has been held sufficient to arm the forts with guns of small and medium caliber, we ought to be persuaded of the necessity of the possibility of arming them with cannon of great caliber. With the huge guns with which the forts should be armed it would be necessary to obtain such ranges that would keep the mortars and the shells of the attack very far from the said forts and in a condition powerless against the fire of the guns of the fort.

With regard to the method of constructing the forts with a view to rendering them not easily destroyable, the author contends that it is useless to increase the thickness of the armored covering to obtain greater protection against each cannon shot of the enemy's artillery. For this there is only one way, that is to follow the lines of field fortification by diminishing the targets, concealing the ground, and breaking up the elements as much as possible.

This is the method of permanent fortification with which the Germans now commence to fight. But there is need to record that all the fortresses of Belgium and France which were left to themselves were soon conquered; and only those which acted in strict unison with the field army have been able to present a good resistance.

The anonymous author commences his writings by saying that he is more than ever convinced that permanent fortifications are still necessary for the defense of the country. They should with small forces be able to resist for a long time on determined points or in regions of special importance, hostile forces, greatly superior to them. And it is obvious that they will serve such a scope, so much the better, as they are properly located, and their power of passive resistance will be so much the greater as is the power of their arms and equipment. As much as is the defensive organization of the fort, so much the less will be the part of the field army necessary for guarding it, and on the contrary so much the greater will be the forces of the enemy arrested in front of it.

The arguments which, since the experience of modern wars, are brought forward in support of the theories which consider permanent fortifications as impotent in the face of the new and very effective methods of attack have no serious foundation. There are indeed some who in their enthusiasm for the value of trenches and field fortifications, think that the latter can be substituted for permanent fortifications.

Do they not lose their senses?—exclaims the author—Do they not forget how much France owes to its fortifications? Do they not lose sight of the very great value of the German fortresses on the western frontiers in event of the troops being obliged to retire?

It should be remembered that fortresses may grow old in the same manner as ships of war. At this point the author expresses as follows the ideas according to which by his advice the permanent defense of a country should be organized.

For the purpose of properly defending its own territory against invasion a state should limit itself to constructing, near its frontiers, some fortresses and assigning to them certain special duties. As an efficacious assistance to the mobile defense by the troops, and for the absolute security of a state against an enemy's invasion, especially in a territory with open frontiers, a system of forts connected by extended lines of passive and insuperable obstacles, natural and artificial, is the only one of service. For such a system, an organization of vast entrenched camps, like those of the French at Belfort and Verdun, is not necessary; extended battle camps with permanent works are sufficient; such as will admit between their intervals of the offensive action of the troops and against which the enemy's attacks may be split up and broken.

Such a system of battle camps with permanent works should be adapted to tactical requirements in the same manner as improvised fortifications. The military engineers instructed in the duties of defending a certain zone, and holding account only of this, and of the nature of the ground, should determine the position and the structure of the necessary works, independently of any preconceived ideas. Case by case it should be decided how best such permanent battle camps can be organized, either with a line of forts or with groups of works, without rigidity, and without being strictly tied to a linear system or to that of groups. In each camp there should be strong closed works, well armed, well equipped, secure against assaults, *di viva forza*, and with great development of fire, constituting the nucelus of the whole system.

The author attaches a sketch to his article, representing one of such modern places of support, protected according to his principles, noting that the data referring to the various dimensions are only vague indications, especially as regards the thickness of the armored protection. For general rules he offers the following:

1st. To maintain a most efficacious fire action against the vicinity of the attack, even up to the last stage.

2nd. To support the contiguous works, fighting the intervals with batteries conveniently disposed.

3rd. To be absolutely secure against attacks *di viva forza*.

4th. To be able to impede the enemy from establishing himself in the interior.

A successful defense up to the last stage can only be effected by

following means: mitrailleuses and special guns of small caliber; the use of the strongest armored protection for the guns and the garrison; the concealment from view and the disposition of such protection.

It would be difficult to construct a gallery for infantry and mitrailleuses with armored protection without it being visible. Small protected emplacements concealed by bushes, for one or two mitrailleuses, might be preferable. Armor-covered batteries should be provided for supporting the neighboring works by their fire, and be placed between the closed works in the positions best adapted for the purpose. Passive security should be obtained by a a very extended use of barbed wire, with current at high tension, guarded by small armored posts. To impede the enemy from establishing himself within the works there should not exist in the ditch any small places in which he could take up a position against the reserve batteries of the defense.

The author closes his article with a remark on the ungrateful duty of endeavoring to find a compromise between the principles which he recommends and the expenses spent on construction.

—From *Rivista di Artiglieria e Genio* in *The Royal Engineers Journal.*

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KATO WARNS JAPAN OF NAVY'S DEFECTS

Admiral Tomosaburo Kato, the Japanese Naval Minister, discusses in the January issue of the *Japan Magazine* of Tokio the naval expansion of Japan. In this article the Japanese minister asserts that a decade ago the Japanese Navy was ready to meet any power that might have appeared in eastern waters, but adds that owing to what he calls "straightened circumstances" the Japanese Navy does not enjoy the standing it once had. Japan's only desire in a naval way, he adds, is a navy adequate to defend the empire.

"Japan's navy has not at all expanded proportionately to her wealth; and no nation should permit its defenses to fall below the position to which destiny brings it.

"It is to fill up this fatal defect in the defenses of our great empire that the naval authorities ask for repletion. For this Japan must have at least 12 battleships of the *Fuso* class, and even then her fleet will still be inferior to some others. Left as it is now, the Japanese Navy will be worthless in case of war. Should emergency arise the nation has no right to expect the present navy to meet and defeat any enemy of importance. Ships are as necessary as personnel to insure victory.

Japan's Naval Plan

"If the plan now under contemplation is completed, Japan will have but four ships of the *Fuso* (31,500 tons) type and four new battle-cruisers of the *Kongo* class (27,000 tons), while Germany will have 41 battleships and 20 battle-cruisers; and the American Navy is expanding at a corresponding rate. Russia, too, is building up a great navy of three squadrons of 12 units each, compared with which the navy of Japan will be quite insignificant. Consequently, Japan can never afford to be satisfied with her present naval plans if she expects to maintain the position she has won. She will then be obliged to take her place beside China, Greece, and Spain. Japan must replace her present obsolete units by units of modern efficiency.

Our plans are not sufficiently ambitious, but we cannot go beyond our finances. We are attempting the maximum that our funds will allow. This makes the defects in our defenses all the more serious, especially at a time when world-war is raging and one cannot tell what a day may bring forth. Should unforeseen emergency arise our first action would inevitably be at sea, and the navy would have to face the responsibility. For a nation like Japan the efficiency of naval defense is paramount.

"The safety of the empire cannot be left to the fluctuations of the Treasury. Every day the plan of naval repletion is delayed means one day more of danger to the empire. When the time comes that a nation is unable to meet the outlay necessary to adequate naval defense that nation is bankrupt. To abandon the navy is tantamount to abandoning the state."

—From *N. Y. Times* in *Proceedings U. S. Naval Institute.*

16-INCH GUNS FOR BATTLESHIPS

Experimental long-range firing by the Atlantic fleet and information about naval battles in the European war virtually have convinced the Navy Department that battleships to be authorized this year should carry ten 16-inch guns each, instead of twelve 14-inch weapons. Ships of the *Pennsylvania* and *California* class, now built or building, carry the 14-inch guns.

Details of gunnery are confidential, but it became known tonight that the next target practice of the fleet will be held at ranges up to 18,000 yards because of the lessons taught by the battle between German and British battle-cruisers in the North Sea, where 17,000-yard shots scored hits.

The Navy General Board recommended some time ago that new battleships be designed for the 16-inch rifles, and proposed other military characteristics that made it necessary to increase the tonnage from 32,000 for the *California* class to 36,000. Officials of the Board have urged their views upon the House Naval Committee in connection with the pending appropriation bill, although the 1917 building program is not yet before the committee. Many officers of high rank, however, have considered it unwise to mount the bigger guns or build the bigger ships. Secretary Daniels has not as yet announced what his recommendation to the committee will be, but confidential reports from the fleet are said to have about convinced him of the desirability of the bigger ship project.

An order for the first kite balloon to be added to the navy's aerial fleet has been placed, it was learned today, and this latest device to increase the accuracy of gun fire may be tested out during the Spring target practice. It is proposed that each battleship be equipped with a captive kite balloon which will rise 1000 feet above her decks. The officers observing the fall of shots, now stationed in the fighting tops 150 feet above decks, will be stationed in the balloon basket, communicating with the gunners by telephone. From their great elevation they will be able, it is thought, to direct salvo fire with deadly accuracy at targets invisible from the ship itself.

The navy's biggest guns now have a range of 12 sea miles or more, and this will be increased materially with the new 16-inch guns. Before the House Naval Committee recently Admiral Winslow said he had seen weather

conditions in which ships were plainly visible at 30,000 yards, or fifteen miles. It probably was due, he said, to a mirage, but if he had guns of sufficient range he thought he could have gauged his shots so as to make a bombardment effective.

Another new feature probably will be added to the fleet this spring when the armored cruiser *North Carolina*, carrying six aeroplanes and their crews and a device for launching the aircraft in any weather, joins Admiral Fletcher's command. The aerial scouts for the first time will play an important part in the maneuvers and possibly in target practice.

—From *N. Y. Times* in *Proceedings U. S. Naval Institute.*

THE *GOEBEN'S* ESCAPE

German Version of the Maneuver

A semi-official history of the adventures of the *Goeben* and *Breslau* has been published in Germany. Its author, Emil Ludwig, says he acquired the facts at first hand during a visit to Constantinople. He has apparently had access to the log book of the *Goeben*, and has received information regarding the flight of these vessels from the commander-in-chief, Vice-Admiral Souchon, * * *.

The author says that on August 6, 1914, at midday the admiral issued the following order to the three ships under his command at Messina:

News about the enemy is uncertain. I presume his strength lies in the Adriatic and that he is watching both exits in the Messina Straits. Object: To break through to the east and reach the Dardanelles. Order of going: *Goeben* leaves at 5 o'clock, at 17 miles an hour; *Breslau* follows at a distance of five miles and closes it up at darkness. I want to create the impression that we are wanting to go to the Adriatic and in case I so succeed in creating the impression that we are wanting to go to the Adriatic, we shall veer round in the night and make for Cape Matapan, if possible, throwing off the enemy. The steamer *General* to leave at 7 o'clock in the evening to keep along the Sicilian coast and to try and reach Santorin. Should she be captured, to try and let me know by wireless. If she receives no further orders from me, to ask for them at Loreley (Constantinople station ship).

As the ships—flags flying and music playing—were reaching the open sea the following wireless message from the Kaiser reached the admiral: "His Majesty expects the *Goeben* and the *Breslau* to succeed in breaking through."

Shortly after leaving the harbor an English cruiser of the *Weymouth* class, alleged to be the *Gloucester*, appeared on the horizon. The English cruiser was emitting signals in three groups. The word "Mumfu" frequently occurred, and it was clear that it referred to the *Goeben*. The wireless receivers finally deciphered the signal of the British cruiser as follows: "*Goeben* making for the Adriatic."

The German wireless officer argued thus: "I can jam him. If I break my waves against his I can confuse, hold up, destroy his messages. Shall I jam his wireless?" he asked the admiral.

"Shall we fire?" asked the commander.

"No," was the answer to both questions. No one apart from the staff understood the admiral. This is how he argued, however. "This boat is

evidently a patrol intending to wireless our movements to the main British fleet. He shall save us, not ruin us. He shall do his work. We shall neither fire at nor jam him. Let him wireless that the Germans are making for the Adriatic, whereas the Dardanelles is our object."

It was dark. The *Breslau* closed in. It was 10 o'clock in the evening. Then came the order from the bridge: "Right about; starboard; make for Cape Matapan."

The watching British cruiser saw the maneuver, but before it could wireless the news that the Germans were making for the east the following order flashed out from the admiral: "Jam the wireless; jam it like the devil."

For hours the Germans were travelling eastward without obstacle, while the patrol boat tried to make itself understood in vain. Where did the error of our enemy lie? In England the excuse was advanced that the Germans had acquired knowledge of the British secret wireless code and so deceived the latter into waiting. Is it worth while contradicting such stuff? The English should have waited before the Straits of Messina and nowhere else. But so confident were they that the *Goeben* and *Breslau* must try and break through to the Adriatic in order to reach an Austrian port that they thought it safe to wait in the straits of Otranto, which are 40 sea miles wide. So positive were they on this point that the thought of our making for the Dardanelles never seemed to have occurred to them.

The writer admits that the wireless messages of the cruiser which he calls the *Gloucester* evidently reached the British fleet, but they reached it too late—the German ships were en route for Constantinople.—From *London Times* in *Proceedings of the U. S. Naval Institute.*

Photograph by Boston Photo News Co. 1826

AUSTRIAN 15-CM. GUN ON THE BESSARABIAN FRONT
(IN THE FIRING POSITION)

VESSELS BUILDING

GERMANY

Name	Displacement	Speed	Armament	Builders	Remarks
Battleships					
Ersatz Wörth	29,000	--------	8 15-in., 16 5.9-in.	Kiel	Laid down Sept., 1913
"T" 1913	29,000	--------	" "	"	" " May, 1913
Ersatz Friedrich III	30,000	--------	8 15-in., 18 5.9-in.	--------	" " Summer 1914
Cruisers of the Line					
Ersatz Hertha	28,000	28.5	8 12-in.	Wilhelmshaven	" " July, 1913
Ersatz Victoria Louise	--------	--------	--------	--------	" " Summer, 1914
Vessels Building in July, 1914, and now Completed					
4 Battleships					
Grosser Kurfürst class	25,388	22	10 12-inch	--------	Completed in 1914-15
2 Battle Cruisers					
Derfflinger class	28,000	27	8 12-inch	--------	" " "
5 Light Cruisers					
Ersatz Hela class	5,500	27.5	10 6-inch	--------	" " "

NOTE.—In July, 1914, Germany had building approximately 24 destroyers and 18 submarines.

No accurate information regarding naval matters has been obtained since the outbreak of the war, but it is reported that ship construction has been pushed to the full extent of building facilities.

GREAT BRITAIN

Name	Displacement	Speed	Armament	Builders	Remarks
Battleships					
1 Ship	27,500	25	8 15-inch	--------	To be completed in 1917
Renown	25,750	22	"	--------	" " "
Repulse	25,750	22	"	--------	" " "
Resistance	25,750	22	"	--------	" " "
Revenge	25,750	22	"	Vickers	" " " 1916
Resolution	25,750	22	"	Palmer	" " "
Ramillies	25,750	22	"	Beardmore	" " "

GREAT BRITAIN—Continued

Vessels Building in July, 1914, and now Completed

Name	Displacement	Speed	Armament	Builders	Remarks
Battleships					
2 Revenge class	25,750	22	8 15-inch	--------	Completed 1915
5 Queen Elizabeth class	27,500	25	"	--------	" 3 in '15; 2 in '14
1 Battle Cruiser					
Tiger	30,000	30	8 13.5-inch	--------	" in 1914
Light Cruisers					
8 Cleopatra class	4,400	30	--------	--------	" " 1914-15
6 Arethusa class	3,600	30	--------	--------	" " "
3 Birmingham class	5,440	25.5	--------	--------	" " 1914

NOTE.—Approximately 31 destroyers and 21 submarines were building in July, 1914.

Since the war no official information regarding naval matters has been available, but it has been reported that the number of vessels building has geen increased to the full capacity of the ship yards and that new vessels have been laid down as fast as those building have been completed. Also it has been reported that five large battle cruisers of 32 knots speed are nearing completion and that a number of monitors carrying 14-inch guns are either built or building.

JAPAN

Name	Displacement	Speed	Armament	Builders	Remarks
Battleships					
Yamashiro	31,300	22.5	--------	Kawasaki	To be completed in 1916
Ise	31,300	22.5	--------	Mitsubishi	" " " "
Hinga	31,300	22.5	--------	Yokosuka	" " " 1917

Vessels Building in July, 1914, and now Completed

Name	Displacement	Speed	Armament	Builders	Remarks
1 Battleship					
Fuso	30,600	22	12 14-inch	--------	Completed in 1915
2 Battle Cruisers					
Haruna class	27,500	28	8 14-inch	--------	" " 1914-15

NOTE.—In July, 1914, Japan had 2 destroyers and 2 submarines under construction in England and France respectively.

—*Proceedings U. S. Naval Institute.*

NOTES ON COMBINED NAVAL AND MILITARY OPERATIONS

By "G"

I. Signalling

During the operation of landing troops in the face of the enemy and the operations subsequent thereto, an efficient service of signalling between the shore and covering ships and transport vessels is a point presenting considerable difficulties, and one the importance of which cannot be too emphatically insisted upon, if the fire of the covering ships is to materially assist the troops.

The types of signals which it will be required to make, fall under four main headings—

1. Signals asking for fire from covering warships to be directed on certain spots.
2. Signals concerning boats.
3. Signals dealing with the disembarkation of troops, guns, stores, ammunition, animals, etc.
4. General signals.

In order to be of service to the troops on shore, covering fire from warships must, in the majority of cases, be opened within a minute or two of the receipt at the Shore Signal Station of the telephone or visual message from the firing line. Signals concerning boats should rarely be necessary provided the beach, transport, and hospital parties are efficiently organized and run. A digression on the organization of boats for various duties does not fall within the scope of this article, but it may be remarked that with some hundreds—literally, of boats employed constantly running between—in landing on a beach, even if free from rocks, steamboats can be employed for the purpose of towing only, and must cast off the tows when still some distance from the shore. The sharpness of the stem of the Service picket boat renders it unsafe for her to approach too closely to the beach for fear of grounding or damaging her propeller. Service pulling boats, on the other hand, are so constructed that they can be easily pushed off when aground. Also they draw very little water, whereas a picket boat cannot approach a shelving beach close enough to enable troops to wade ashore.

During the landing operations on the Gallipoli Peninsula the available boats of each ship were divided into two tows, each consisting of a launch or sailing pinnace, cutter, and two lifeboats. The carrying capacity of each tow was thus 135 to 150 men. Boatkeepers were detailed, to each lifeboat two and a coxswain, to other boats four and a coxswain each. To each of the three battleships were also supplied two duplicate tows, so that the total number of troops which could be landed in a single trip by the four tows of each battleship was a half battalion. Machine-guns and stretchers and bearers were landed with the covering troops.

In command of each tow was an officer in the steamboat, in each pulling boat a midshipman was in charge, and in addition an officer should be carried in one of the pulling boats of each tow, for the purpose of taking charge when the steamboat casts off the tow. All the tows should be under the command of an officer whose position should be in one of the steamboats on the flank, and who should be responsible for keeping the direction.

Prior to embarking in the ship's boats the troops should be fallen in on deck opposite the boats into which each unit will be conveyed to the

shore, at least one gangway ladder being provided for each boat. Each unit must know its own boat and its own gangways, and where to assemble. This is especially important if the disembarkation is to take place at night when the ship is darkened.

During the subsequent work of keeping the troops ashore provided with reinforcements and supplies, considerable arrangement is required in order to prevent confusion and to get the best work out of the boats available. The running of the boats should be controlled by a Staff composed of both naval and military officers. From this Staff are furnished the Naval Beachmasters, whose duty it is to regulate the arrival and departure of boats and superintend their unloading, and the military officers who take over the contents of the boats when unloaded. It should be clearly understood that it is no part of the Beachmasters' duties to detail boats for different work, except in so far as they are the mouthpieces of the Boat Staff, who must be on the spot, and to whom all arrivals and departures of boats should be reported. Further, the duties of the Boat Staff should not overlap those of the Transport Officer and his Staff, who report to the former the disposition on board the various transports and storeships of troops, guns, animals, stores, etc., and leave it to the Boat Staff to disembark these on shore as ordered by the Headquarters Staff.

Certain boats may be required for the removal of wounded to hospital ships. Boats should be permanently kept at the same type of work, such as landing guns, horses, troops, or stores; or embarking wounded, and not shifted unnecessarily to some other work with which they may be less familiar. During long spells of enforced unemployment boats should be allowed to return to their ships, in order to rest the crews, who should work twenty-four hours at a stretch. Good signal or wireless telegraph communication with the ships is essential for the rapid communication of instructions to the boats. Boats should be allowed to act on no orders other than those of the Boat Staff; the commandeering by a senior officer of a boat temporarily unemployed may have far-reaching consequences. Allowance must be made for a proportion of breakdowns and losses of boats. To obviate possible trouble at transports, officers, and midshipmen in charge of boats should be given written orders when necessary.

The subject of tugs, trawlers, etc., which may well be employed if available, for towing heavy lighters, has not been touched upon. Such craft should be in charge of naval ratings and act under the orders of the Boat Staff.

II. Boatwork

Not the least important of the elements which make for success in landing operations is the efficient handling and running of boats. The recent operations in the Dardanelles have provided much experience, both in the handling of boats from the time of their being hoisted out or lowered for the landing of the covering troops, and in the running of the boat service during the time that the troops on shore are dependent on the Navy for all supplies, ammunition, and the landing of further troops and guns, for the most part under fire.

The method employed in the Dardanelles serves, with the alterations and additions imposed by the light of experience, as an excellent model.

The covering troops for the Australian and New Zealand Army Corps, which landed at Gaba Tepe on the 25th April, consisted of one and a half

battalions of infantry, three battleships being detailed for the duty of putting the force ashore.

The boats available in each battleship consisted of two steamboats, one launch, one sailing pinnace, and two cutters. This number was further augmented in each case by the addition of four lifeboats to each battleship, of the type carried in liners and well-found merchant ships. These boats are capable of carrying some twenty to twenty-five armed and equipped men each. The capacities of service boats under similar conditions are:

Launch	80 men
Sailing Pinnace	65 "
Cutter	30 "

At first sight these figures may seem to be an under-estimate, but in practice it is found that a soldier armed and equipped with pack, water-bottle, and bulging haversack occupies in bulk 50 per cent more space than the same man without equipment, and in weight 30 per cent more. It is also necessary that space should be left in the boats for the men to pull the oars, since for both ships and shore the maxim "order, counter-order, disorder" more than ever holds good. The type of signal, however, which may reasonably be expected is one ordering boats to proceed to a certain ship or to the shore, they having been allowed to proceed to their ships while temporarily unemployed, or a request for all available boats to cope with an extra large batch of wounded expected after some unusually heavy fighting. During the recent landing of troops on the Gallipoli Peninsula, owing to the lack of sufficient base hospital accommodation nearer than Alexandria, and the fact of the beaches being for so many weeks exposed to the enemy's shell and even rifle fire, all wounded, after having had their wounds dressed, were at once sent off in boats to one or other of the hospital ships or transports, which, as they became filled up, left for Malta or Alexandria, returning again after discharging their wounded and filling up with coal, water, and stores.

The third type of signal, though it does not require to be acted upon so absolutely immediately as a signal asking for covering fire, necessitates, nevertheless, careful coding, transmission and, if necessary, re-transmission to the authority to whom it is addressed, with a nice appreciation of its degree of urgency. It is rarely that an operation can be conducted without such signals as "S.A.A. Ammunition required immediately," or "Urgent, land field howitzers," etc., being made occasionally.

Under the heading of general signals fall the hundred and one messages, reports of progress, lists of casualties, messages from "Signal officer to ditto," reports from Intelligence Officers, congratulatory messages, signals to transport and other officers, which are incidental to such an operation as a landing in the face of the enemy.

In evolving a system of signalling between ships and the shore which shall fulfil all requirements, other considerations require to be taken into account, in addition to making provision for the various types of signals which may be expected. The number of Naval signal ratings and wireless telegraph operators and their military counterparts is limited, in the sense that a certain number only is available, and more cannot be improvised. Owing to the difference which exists between the methods of procedure in the Navy and Army, it is of the first importance that every shore signal station should be a combined Naval and Military station, irrespective of

whether it is under the control of the Navy or the Army, and whether it is equipped for visual or wireless methods of communication, or, as it should ideally be, equipped for both methods. The complement of signal and telegraphist ratings borne in H.M. ships is based on requirements of the work of the ship in question, and does not allow of any considerable number being landed without undue strain being placed on the remainder, to the detriment of their reliability. More particularly is this the case with regard to wireless telegraph operators, who, moreover, are in proportionately greater request owing to the necessity of establishing, at such points as the aeroplane base and the Naval base of operations, low or medium power wireless stations, in addition to those established in rear of the firing line, primarily for communication between ships and shore. The difference, again, between the methods of procedure employed in the Royal Navy and Merchant Service necessitates the stationing on board transport vessels and hospital ships of naval telegraphists and signal men, if rapid and efficient direct communication is desired from warships and the shore.

The number of instruments available—heliographs, W/T sets, lamps, telescopes, etc., must also be taken into consideration. Signalling flags can be made on board warships, where signal lamps exist in plenty; telescopes can always be obtained in sufficient numbers on board, where, also, to a limited extent, portable and other W/T sets for shore work can be improvised.

The ideal shore signal station is a combined Naval and Military station capable of transmitting visually by every method in use in the Service and by W/T. The naval and military sections of the stations should be quite distinct as regards *personnel*, etc., all messages being received from the firing line by the military section and transmitted to the ships by the naval section. Certain of the stations should be under military control—preferably the flanking stations, the base station being under naval control. The flank stations should, therefore, communicate direct with the firing line or trenches, and also, of course, with the base station. Different types of message are dealt with by the different stations, both of which are in communication with the ships. Thus the flanking stations deal exclusively with fire control and direction signals, other messages being passed by the base station, which should be close to General Headquarters. A distinct wave length is allotted to shore signal stations (the same for all) and should be the wave length of all ships of the group—of all ships, that is to say, which by their fire are assisting to cover the operations of the troops. It is important that messages should be transmitted to the covering ships by some method which will enable fire to be most rapidly opened and distributed to the best advantage. All signals are passed to the flagship or senior officer's ship, on board of which is a military Staff Officer, in collaboration with whom the flagship details the ships which are to open fire in response to the request received for covering fire. Owing to the channels through which each message must pass, any length of time up to one minute will elapse before the spotting signal reaches the control officer on board the firing ship. One round a minute is too slow a rate for covering fire, which consists ideally of rapid bursts of high explosive shell or of shrapnel, the correctors being set to varying lengths. A general spot is therefore made after each burst of fire, the signal either passing through the flagship as before or direct to the firing ship, provided the name of the latter has been notified to the shore station. By this method waste of ammunition is pre-

vented, no small matter where guns of large caliber are concerned, when the small number of rounds comprising the life of such guns is taken into consideration. The principal disadvantage of this method is the length of time taken to open fire in the first instance in response to the signal. For this reason certain ships should be given a roving commission, and will open fire on receipt of signal made direct to them from a shore station. These ships will be able most rapidly to open fire on targets such as moving bodies of troops, guns coming into action, etc. In the case, however, where fire is being directed at forts or permanent batteries, each round or salvo must be spotted, since once the enemy's gunners have been driven away from their guns, the guns themselves of the battery must be hit, it being insufficient merely to damage the parapets or emplacements. In this case each shore station should have assigned to it one or more ships to which signals are passed direct.

The extensive employment of wireless for passing control of fire signals gives to an enterprising enemy considerable scope for the exercise of his talents in intercepting such signals. Were he to confine himself merely to intercepting messages much useful information might be gained by him. Usually, however, he gives himself away by making bogus signals, such as asking for fire to be directed on a spot where our own troops are in position, whereby he is in the end invariably detected, when steps are easily taken to obviate the nuisance. Jambing of signals by the enemy is also serious, though this, too, can be to a great extent evaded; and it has, of course, drawbacks from the enemy's point of view in connection with the delaying of his own messages.

Shore signal stations should be landed and should take up their positions as soon as possible after the landing of the covering force, preferably with the first tows of boats which land the main body. With regard to their positions, the shore stations must remember that it is their duty to so place themselves that visual communication with the covering ships is easy. For a battleship to shift berth owing to inability to read a shore station in its present position, is an affair necessitating the expenditure of far more time and energy than for the shore station to shift a few yards. The signal bridge of a ship is a clearly defined mass, whereas it may often be difficult to pick up a flag or lamp half hidden from view in a dug-out or in thick trees.

The employment of a simple code of fire control signals expedites very considerably the passing of such messages, though greater care on the part of the operators is then necessary than when signals are made in plain language, since a single letter wrongly received may entirely alter the sense of a signal.

III. Covering Fire

The different natures of covering fire from warships which may be required for the assistance and protection of troops on shore are roughly two.

1. Fire directed at moving targets such as bodies of troops.
2. Fire intended to destroy the enemy's trenches, emplacements, guns, etc.

The employment of such fire is uneconomical when the effect thereof is compared with the expenditure of ammunition. There are two main

reasons for this: first, the low trajectory of the naval gun; secondly, the difficulty of accurately spotting the result of the fire. On the other hand, the shattering effect of the large caliber guns mounted in warships is enormous.

The possibility of battleships being employed in covering troops on shore with fire had hardly been considered prior to the present war; consequently, the naval gun is of a type which develops its greatest effectiveness when used against other ships. In a ship *v.* ship action it is of great importance that the trajectory of the guns should be as flat as possible in order to increase the danger space at any range. The relation between vulnerability to high angle fire (that is, where naval guns are concerned, long-range fire), with low percentage of hits, and comparative invulnerability to low trajectory fire, with high percentage of hits, has not received from experts the attention to which it would seem, in the light of the experience gained in the present war, to be entitled.

When firing at objects on land, the disadvantages of a flat trajectory may to a slight extent be counteracted by the substitution of reduced for full charges of cordite. The drawback to the employment of reduced charges lies in the shifting of sight dials which becomes necessary, with consequent delay, if it is suddenly necessary to open fire at a range beyond that of reduced charges. If the firing ship is under weigh, the difficulty is obviated by using the helm to bring another group, or another battery of guns to bear on the object. When, however, the ship is at anchor, it may happen that only a small proportion of the guns will bear at a given moment, and when covering the advance of troops on shore, or assisting their defense, the firing ship will only be under weigh in the rare event of the target being visible to the gunlayers. At other times the guns will be firing on a given bearing, the fall of shot being spotted by observation officers on shore or elsewhere.

Attempts have been made to mount howitzers in battleships. The results obtained have proved, however, unsatisfactory, since a ship is never entirely steady, even on a calm day, unless lying in an enclosed harbor.

Observation of fire may be carried out by captive balloons, by aircraft, or by observers on shore. If the observation station is in a good position the latter is the most satisfactory method. In every case good communication with the firing ship is essential. When covering troops, rapid bursts of fire lasting for five minutes or less are economical and effective, a general spot being made at the conclusion of the burst. When destroying a fixed target, such as enemy trenches or guns, each round or salvo must be spotted, and for this purpose aircraft or captive balloons may well be employed. In this case, however, not more than one ship should fire at the target at one time.

In firing at stationary targets high explosive, lyddite, or common shell are required, since it is necessary in most cases to hit the object aimed at in order thoroughly to destroy it.

The study of the possibilities of shrapnel did not, until some four months ago, greatly occupy naval experts, its employment being chiefly confined to use against destroyers and unarmored vessels. With the commencement of operations in the Dardanelles gunnery lieutenants set to work on the study of this type of shell, and amazing results are sometimes obtained by large caliber guns, the accuracy of many types of which can only be compared with that of the traditional cowboy with lariat or stockwhip.

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FIGHTING IN THE AIR

The Influence of Design on Tactics

Fighting in the air has this, among other features which distinguish it from other modern fighting—that it is notably visible, whether to those at the front or at the back of the front. The movements which constitute a fight and the features of the aeroplanes which lead to these movements may be considered.

Talk of armor on aeroplanes has tended to lead the ordinary inquirer to suppose that such armor protects, or is intended to protect, one combatant from the rifle fire of the other. This is not the case. On no aeroplane, British or foreign, is the armor, as far as is known, at any rate, of such thickness as to withstand any of the shots which are fired at it from the air. In these circumstances the only defenses the airmen have are those produced by maneuvering.

MANEUVERING FOR POSITION

An astute airman observes the class of aeroplane opposed to him, learns whether both pilot and gunner are armed, notes the position and restrictions introduced by the position of the enemy's gun mountings, and strives to take up and keep as long as possible such a position that a part of the enemy's machine itself balks him. The enemy swoops or swerves to clear his field of fire, but, given that our man has adequate speed, he strives to get a corresponding shelter from some other member of the opposed aeroplane. The gunner, by the movements of his gun, which is in most of our aircraft visible to his pilot, gives a clue as to the direction in which he is prepared to fire, or alternately a clue is afforded by the movements of the aeroplanes about one another. On the harmonious working of the double brain success depends.

Both pilot and gunner are usually armed in British aeroplanes, and their opportunities depend on their relative positions. To take an example, on an Albatross tractor biplane (such as the R. F. C. have captured more than one of) the gunner is not situated in front of the pilot, but behind him. He thus loses the opportunity of showing by his gun which way he desires the pilot to fly, but in return he secures a sweep of the horizon rearward without finding the pilot's head in the way of the weapon. In a backward direction only the tail plane obstructs his view. In the more usual arrangement of tractor aeroplanes used by the Allies the gunner and his ammunition are in the center between the pilot and the engine. He has nearly as good a field of fire aft as the German (when the pilot bows his head out of the way) and a far better field in a partly forward direction. The German pilot, occupied with the balancing of his aeroplane, is not able to do what our gunner can do from the like situation, viz., utilize the clear interval that exists between the propeller disk and the wings for fire which may be directed partly forward.

Ability to fire forward is very important, since it means ability to attack while approaching, while the German's chief preparation is for firing when departing; it would not be correct to call this retreat, since it need only be a maneuver to shoot. It is clear that German aeroplanes are not stable, and to that extent British pilots are more free to employ their weapons than are their adversaries. The Germans have in the Albatross and some other craft an elaborate rotary turret with rotary seat for the gunner's

convenience, thus providing for his comfort in a manner which *pro tanto assists accuracy.*

USE OF RAPID DIVING

Given that the German and British tractor biplanes thus indicated are engaged, the gun arrangements of the German evidently induce him to dive below his opponent. In this way he not only interposes the landing gear of the British machine between himself and the British gun, but also allows his own gunner a good passing volley at the aeroplane overhead, and he finishes with his tail toward our machine—his best position for fire. A very slight deviation of dive gives a great access of speed; 100 miles an hour will be attained by such an aeroplane after a dive of only one second.

If our aeroplane has a reserve of power and can get 100 miles an hour on the turn without diving we get back to a position much the same as before, save that our machine is on top. If it is directly on top the German cannot be seen well, but the top position is in itself an advantage since the height can be converted into speed at any moment. We probably "bank" the aeroplane to give the gunner a good field of fire, and arrange that the curved path resulting from that "bank" does not lead us too far away from the quarry.

If our aeroplane cannot achieve the 100 miles speed the kind of thing which happens may be as follows: Either the German gets well away and fires at us comfortably backward and upward, while our own gunfire is handicapped by the presence of the propeller disk of our own machine between us and the enemy; or, alternatively, we also dive for speed and so maintain the relative shooting positions that the enemy was striving to get out of. All would be equal enough in these circumstances were it not that our air fighting is mostly undertaken over the enemy's country, since he is not fond of coming over ours. The outcome might be a repetition of the double maneuver and descent till we must decide to call off because a final descent into enemy country suits him and not us.

THE FIGHTING "PUSHER" MACHINE

In the above example we have taken a couple of tractor aeroplanes as being the type most numerously represented in all armies at present—for armies had envisaged reconnaissance and scouting as the main aerial duties. Other types, however, of which the chief forerunner was the Farman, are coming more and more into evidence. In these types the propellers are at the back of the body and wings, and so is the engine, thus clearing obstructions from the field of fire forward. The gunner can be placed ahead of everything else. He can fire right up and fairly well down, and has a splendid lateral angle—well beyond 180 degrees—of clear field of fire. That is to say, an enemy who is behind him, if to one side, can still be fired on.

This arrangement, which is *par excellence* the "Fighter" or "F" aeroplane, has in one form or other been produced by many British makers, including the Aircraft Company, Vickers, the R. A. F., Short Brothers, Boulton, etc., and some say that since reconnaissance and artillery direction can be effected easily and well from a "Fighter," while fighting suffers restrictions in a Reconnaissance or "R" aeroplane, the Fighter is the machine of the future. Given that a Fighter attacks an Albatross of like speed, the Fighter has the advantage. To escape from fire the Albatross must

get behind the tail of the Fighter, and his pathway to that position is one which he will desire to cover at the maximum possible speed. Hence again the enemy dives for speed, if possible, under our machine, since he can fire upward as he passes, and so get behind it. If we have quick maneuvering powers we can prevent this by so turning as to keep him in view, descending or not as may be dictated by the call for speed. From all this it is clear that, quite apart from the necessity for keeping high to baffle the accuracy of shrapnel fire from the ground, it is desirable to approach the enemy as high as possible, and rapid climbing is for this of enormous value.

In encounters such as these the advantage of having more than one machine pitted against one is overwhelming. The effectiveness of numbers in aircraft fighting was proved a year ago in an article in the *Engineering Supplement*, reviewing Lanchester's work on the subject, to be proportional to the square of the numbers—so that two are four times as formidable as one. Anyhow, it is clear that a pilot would indeed be a prodigy who could keep his machine simultaneously in the no-danger area of two adversaries' machines for an appreciable time.

THE PRICE OF "CONVENIENCES"

When a British aeroplane of Fighter type meets the same type face to face the equality of opportunity throws the whole outcome of the battle upon skill in shooting and in maneuvering. The aeroplane designer can help by giving the pilot the most perfect response to the minimum of effort in the controls, by giving the pilot a stable aeroplane, so that if he abandon his controls to devote himself to shooting, we get two guns to one without jeopardizing the machine, and lastly by providing the gunner and the pilot with "conveniences"—e. g., relieving them of the necessity for taking up an inconvenient or unsteady attitude when handling the gun, keeping their hands reasonably warm in the intolerably cold air above, and so on.

All conveniences, whether by giving large space to turn about in, good gun rests with elbow cushions, rotary or swinging turrets, plenty of ammunition, warmed nacelle, duplicate tanks, double controls, folding wings, thicker armor, involve one and the same penalty. They load up the aeroplane and spoil its climb, or its speed, or sometimes even its controllability. They always increase the speed of alighting and therefore the risk of a smash on return. How far to poach on one merit for the sake of another is, indeed, a nice problem, all the more difficult of solution that the utmost inconsistency exists in the experience and tastes of users, naval and military. All users are in favor of all conveniences until they become clear as to the price to be paid. Then they divide into schools. To add all the conveniences together in one aeroplane of the same performance can, of course, be done, or nearly done, on one condition—that the aeroplane be one of monstrous size, requiring very large engines and, most important of all just now, taking an immense time relatively to design, build, engine, and equip in any quantities. The trouble is, of course, the narrowness with which military aeronautics was starved for money in time of peace. Those paper philosophers who some months ago had up their sleeves a secret source of production by which 10,000 aeroplanes were to be produced in a few months by some fantastic scheme might usefully come forward with 1000 of these larger craft (which would each take about ten times as much labor and material as a small aeroplane), and thus put at the disposal of the authorities a supply which would not incommode them.

TRACTORS AND PUSHERS

Let us now return to the *pros* and *cons* of the Fighter and Reconnaissance (popularly known as the Pusher and Tractor) types of aeroplanes and their future prospects. We have indicated the great value of quick climb, high speed, quick maneuvering, and stability. Does the Fighter type—as a type—lower the performance in any of the quantities below what could be effected with the same engine on the tractor type? The answer would appear to be that it does, in some degree, and when the answer can be made precisely and quantitatively it will be possible to say wheter the tractor type is dead or not. So far we know that up to the war period with 100 horsepower of engine the "tractor" achieved the best speeds and climbs, that it is the most controllable, and that it can be made stable. The future will disclose what the modern pusher aeroplanes have done and are doing abroad. That they exist both the German and the British public are well aware. All pushers have a higher head resistance than tractors, and to achieve performances with them equal to those of tractors will be a difficulty. If it is found to be fundamentally impossible to equal the fastest tractor-scout with the fastest pusher, then the tractor-scout will doubtless be retained as an arm for its own special high-speed work.—From *London Times Engineering Supplement* in *Scientific American Supplement.*

A NEW USE FOR THE SEISMOGRAPH

By Robert G. Skerrett

The seismograph as a means for determining the duration and the violence of distant earthquakes has served its purpose for a long time. Latterly, a series of these have been so employed that they could locate by triangulation the approximate source of the disturbance. This, of course, being deducted from common knowledge of well established "faults" in the earth's crust. Through these combined agencies earthquakes thousands of miles away have been spotted, so to speak. But now comes a far more novel adaptation of seismological instruments; this time as a military aid.

Prof. Belar, an Austrian scientist of repute, and for the past 20 years an investigator of seismological problems, has had recourse to his special instruments to record the earth shocks due to gunfire. It just so happens that his work of latter years has been at Laibach, where he has been in charge of the seismic observatory. Now Laibach is about 50 miles away from one section of the Isonzo front where the Austrians and the Italians have battled so desperately. There, some of the heaviest artillery duels have been fought, and knowing something of the awful might of modern ordnance it is not surprising that the sensitive instruments at the Laibach Observatory have felt and recorded some of the tremors that have passed through the earth after each bombardment.

Prof. Belar has watched his seismographs day by day as the struggle raged, and through them he has been able to give the world the first "autographic war records" born of earth shocks following the firing of heavy artillery. Such readings may not seem at first blush to have any practical value, but we are informed that from a military point of view the facts are

quite to the contrary. The seismograph has really proved to be a sort of scientific spy and capable of telling immediately things of the utmost importance about the enemy's strength and the distribution of his batteries. This is really the climax of an extensive series of experiments.

About eight years ago, Prof. Belar approached the Austrian military authorities and laid before them a scheme for the military use of the seismograph. At the instance of Archduke Leopold Salvator, Inspector-General of Artillery, tests were promptly undertaken, and the results were decidedly astonishing. The first measurements for determining accurately earth shocks due to artillery fire were made at Gurkfeld, in June of 1907, with especially constructed instruments. In order to get as complete a series of records as possible, the seismographs at that time were placed at different ranges from the guns and howitzers. Topographical conditions were also taken into account. The graphic records disclosed a marked difference between the shocks following the discharge of the weapons and the impact of the projectiles. The tremors induced by the "kick" or recoil of the piece are commonly recorded in the form of short waves which look something like the last three letters of the word "shift" written by hand, while the wave motion resulting from the explosion of a projectile on impact is much longer and has the serrated appearance of a hastily penned "unwritten." It was found possible even to distinguish the direction of the source of the vibrations and also to establish the caliber of the gun if the observer of the seismograph had available a comparative diagram based on previously studied effects of different sized weapons.

The apparatus now employed by Prof. Belar, which is hardly bigger than a typewriter and easily carried about, is so responsive that the inventor is able to identify any street noise, and by a glance at the record can tell whether the cause of the registered wave was a cab, a team of horses, artillery drawn through a distant street, or a train of cars. The records are such that a person once familiar with them—like a stenographer's notes—can see at once what caused them.

It seems that Prof. Belar can readily distinguish the earth shocks occasioned by Austrian guns from those produced by the foe's weapons. That the modern mount of siege pieces and the like do not materially lessen the blow delivered to the earth is proved by the fact that the recoil of the present-day gun is hardly less noticeable than that of the weapons supported on the older carriages. This is something of a revelation. Again, it seems that the apparatus is capable of making a record which is a visible index of the number of guns employed on any firing line.

Of course, the Laibach Observatory is too far removed from the Isonzo front to make legible records of the sort just described, because the observer, for that purpose, must be within 35 miles of the firing line and, at the same time, should be in telephonic communication with his own artillery so that he can isolate the wave records made by the foe's ordnance. Such is the general character of the apparatus which Prof. Belar has constructed for field service. It seems to be well established that the Austrian authorities are very favorably impressed, and well they should be, for what is more important than to be able to locate the enemy's batteries and to determine the number and the caliber of guns thereof? The study of earthquakes has in this case led to both a novel and an extremely ingenious adaptation of the seismograph.

Prof. Belar has gone still further, and a modification of his apparatus

is used for the detection of the approach of enemy craft, and especially for giving warning of the coming of submerged submarines. In this field he has recourse to a "feeler," as he calls it, carried well out from the shore and placed under water—the "feeler" connecting with the detector or seismograph on land. The vibrations set up by the beats of the propeller of the advancing vessel are picked up by the "feeler,"and the character of the wave-records on the recording cylinder serve not only to distinguish broadly different kinds of vessels but to locate their positions and distance away.

—*Scientific American.*

BARR & STROUD FIRE CONTROL ELECTRICAL INDICATOR*

This invention has reference to the electrical transmission of indications from a range-finder to a fire-control or other station where the electrical impulses actuate a receiving instrument which operates a visual indicator (for instance, one exhibiting ranges), or actuates further apparatus which produces motions corresponding to intervals of range on a uniform or other desired scale. For convenience, the term "transmitter" designates apparatus which controls electrical impulses sent to a receiver, and the term "receiver" apparatus directly actuated by such impulses, working on the step-by-step system by means of three or more electro-magnets energized successively. Apparatus operated by the working head of a range-finder, according to this invention, comprises an electrical commutating device capable of being advanced by more than one complete revolution in either the forward or backward direction from a neutral position by operation from the working head through a differential gear, motor mechanism for driving a transmitter and receiver or receivers, working according to the step-by-step system, in which three or more electro-magnets are energized successively, the motor mechanism being adapted to be brought into operation by electrical means, controlled by the commutating device to drive the transmitter in a forward or backward direction in conformity with the extent and direction of advance imparted to the commutating device, the receiver, or one of them, being utilized by operation through the differential gear to restore the commutating device to its neutral position. The drawing illustrates one method of carrying the invention into effect. The upper portion of the figure represents apparatus situated at or near the range-finder, and the lower portion that at the distant station. The range-finder is shown in section at 4, the working head 5 which operates the measuring mechanism of the instrument is geared to a shaft 6, which by means of a clutch 7 drives a shaft 8, to which the bevel 1 of the differential gear 1, 2, 3 is fixed. The spindle of the jockey element 2 is fixed to the shaft 9 which drives a commutator 10. The element 3 of the differential can be driven by the bevel-wheel 11 fixed to a shaft capable of being rotated by a receiver 12. As the working head 5 is turned through any given (say, large) angle the jockey 2 is moved through a certain number of turns and fractions of a turn, thereby causing an equal rotation of the commutator 10. This commutator acts as a device for recording the motion of the jockey 2, and it also serves as a means of operating mechanism to drive receiver 12 and bevel-wheels 11 and 3, so as eventually to bring back jockey 2 to its zero

* British patent No. 28,681/13; February 25, 1915.

position, in which case the number of turns 11 will be a measure of the number of turns of the working head 5. The commutator 10 consists of two metal portions 13 and 14 arranged as shown in the figure, with the brush C^1 resting on 13, and C^2 upon 14. As the commutator 10 is rotated the insulated brush 18 (to which the + terminal is connected) is caused to travel axially by means of the spur-wheels 15, 16 and screw 17. Thus in the position shown in the figure, current will pass from the brush 18 through the part 14 to the brush C^2. This current will operate mechanism shown in the lower part of the figure so as to cause 12 to rotate in such a direction as to bring the commutator back to such a position that the brush 18 is resting upon the insulating portion 19 separating 13 and 14. The motor mechanism consists of a shaft 20, continuously driven, to which is fixed the spindle of the jockey 21 gearing with the bevels 22 and 23. Spur-wheels 24 and 25 are fixed to 22 and 23 respectively. The spur-wheel 24

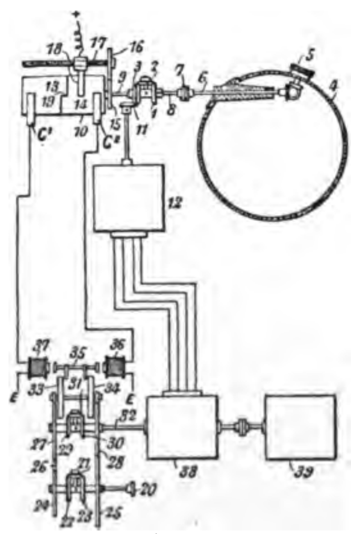

FIG. 1. 1837

drives 27 through an idle wheel 26, while 25 drives 28 directly. The bevels 29 and 30 are fixed to 27 and 28 respectively, while the spindle of the jockey element 31 is fixed to the shaft 32. Gearing into the spur-wheels 27 and 28 are pinions carrying flies 33 and 34 respectively. The arrangement is so designed that if 34 is stopped, shaft 32 rotates in one direction; but if 33 is stopped, the rotation is reversed. The stoppage of one or other of these flies is controlled by a single armature 35, moved to the right when the electro-magnet is energized, and to the left when 37 is energized. In the particular position shown in the figure, where the working head has been suddenly turned through several revolutions, thus bringing the brush to the position shown on the part 14, current will flow through C^2 to 36, thus pulling 35 to the right, and stopping the fly 34. The shaft 32 is then driven in the appropriate direction, causing the transmitter 38 (say of the type described in Specification No. 4422, of 1906) to rotate, and thus driving the receiver 12. This operation will continue till the brush 18 is brought back to the insulating piece 19, when the current through C^2 will be broken,

and 35, under the influence of a suitable spring control (not shown), will be brought back to the neutral position shown in the figure. The transmitter 38 may be coupled to any apparatus 39 which it may be desired to move in accordance with the motions of the working head of the range-finder.—*Engineering* (London).

✦ ✦ ✦

AN IMPROVISED TELEPHONE EXCHANGE

By Lieut. W. P. K. Warren, R.G.A.

This type of improvised exchange has been used in the battery and has been found to work very well. It is made quite easily from very simple materials which can be obtained always.

It is an eight-line exchange and two telephones are used.

The scheme of working is as follows:

Referring to diagram, strips of thin brass *A* are screwed to the base block and have their ends bent up to clear strips *B*. Strips *C* are also screwed to the block and are bent to clear strips *A* and also strip *D*.

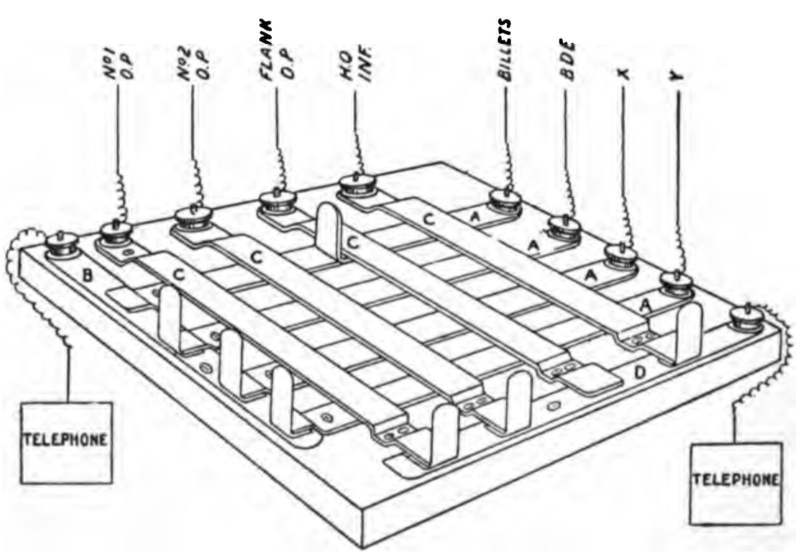

Fig. 1. 1828

Contact between the various strips can be made by inserting a plug, of bent brass, at any of the points where the strips cross.

Normally plugs are kept in all along bars *B* and *D* and calls from the various stations are received in one or other of the telephones.

Diagram shows the arrangement of plugs when *Billets* is speaking *Flank O.P.*

They get no interference from other lines and the battery exchange can tell when they have finished by putting in his plug to telephone now and again.

When shooting is in progress and a clear line from a battery telephone

to an *O.P.* is needed, the other three lines are transferred to the other telephone by moving their plugs up one place.

Thus no line is, even temporarily, cut off.

The brass is cut from an 18-pounder cartridge case.

The terminals come from worn out telephone cells.

The base is 8 inches square and 1 inch thick and should be well soaked in melted candle grease.

The two terminals *X* and *Y* are used for the other section of the battery and the other battery of the brigade.

The lines on the exchange are:

1. No. 1 Observation Post. *No. 1. O.P.*
2. No. 2 Observation Post. *No. 2. O.P.*
3. Flank Observation Post. *Flank O.P.*
4. H.Q. Infantry Battalion in the trenches. *H.Q. Inf.*
5. Officers Billets. *Billets.*
6. The Brigade H.Q. *Bde.*
7. Other Section of Battery. X.
8. Other Battery of Brigade. Y.

Short Notes

German Biplane of Double Fuselage Type.—An account of the capture of a large German aeroplane appears in a recent issue of the *Russkoie Glovo*, which states in part: "Some time ago on the northern front our artillery succeeded in bringing down a German biplane with two unusually large fuselages and two tails. Each of the armored fuselages contains two machine guns and a light, quick-firing gun, besides ammunition receptacles. Propulsion is by twin engines, each developing 170 horse-power. In the center, midway between the fuselages, but a little lower, is the pilot's nacelle, protected by armor. The crew of the machine consists of six men, including pilot, observer and mechanic." Evidently, this machine is a modification on an ascending scale of the well-known "Fritz" type of biplane, which has made its appearance over the western front from time to time.

—*Scientific American.*

New Fokker Monoplanes.—The German monoplane of the Fokker type, of which so much has been said of late, is not strictly a novelty; in fact, it may be said to be designed largely along the lines of fast French monoplanes which have proved most effective in the hands of highly skilled pilots. The special feature of the Fokker monoplane is that its construction is based on steel tubes covered, as a protection against rust, by something of the nature of waxed canvas. The tubes are rectangular in section, and are closed at the rear in knife edges. The engine is armored and usually of 150 horse-power. It is said that the Fokker machines have a speed of 110 miles an hour and can reach a height of 7500 feet in 10 minutes. They are usually designed to carry one person, who is armed with a machine gun which shoots through the propeller in front. In some instances the Fokkers are fitted with two machine guns, each having a belt of 250 cartridges.

—*Scientific American.*

Low-Flying German Aeroplane.—In contradistinction to the greater part of the aircraft engaged in the present war which, in order to secure immunity from anti-aircraft guns, fly at high altitudes, it is learned that the Germans have devised and introduced into service an aeroplane that flies below the line of fire of these guns. It is exceedingly fast and flies so low that anti-aircraft artillery cannot be trained on it so that the shells will burst with accuracy. However, in securing immunity from these guns it comes within range of rifle fire and machine gun fire, and as a protection against these it is heavily armored. Flying close to the ground, the occupants of the new German aircraft are in a position to locate accurately the position of troops and masked batteries, and secure much military information of inestimable value.—*Scientific American.*

A German Anti-Aircraft Gun.—The Germans are using at the present time a 104 mm. anti-aircraft Krupp gun, 45 calibers long, which sends a projectile weighing 15½ kilogrammes, with a muzzle velocity of 800 meters, to a height of 4000 meters. It can be fired at the rate of 15 rounds per minute. The shrapnel shell which it fires is said to burst into 625 fragments. Guns of this type, as well as those of 120 mm., are the ordnance which defends Ostend.—*Scientific American.*

German Aviatik of New Type.—A new type of Aviatik biplane was recently brought down behind the French lines. Its wings, which no longer sweep back as in the earlier types, measures 41 feet in span, with a chord of 6.4 feet. The structure is of oval steel tubing throughout. The engine is a 170 horse-power Mercedes driving a Garuda tractor. The weight, empty, works out at 1600 pounds, and the useful load, including armament, amounts to approximately 1300 pounds. The machine is exceptionally fast and has a climbing speed of 4000 to 4500 feet in fifteen minutes.
—*Scientific American.*

Fifteen-Ton Flying Boats for British Admiralty.—The British Admiralty has ordered 20 triplanes similar to the 15-ton Curtis flying yacht which is now being completed at a plant near Buffalo, according to a recent statement of Henry Woodhouse, governor of the Aero Club of America. The spread of the planes of these machines will be 133 feet, and the propulsion will be supplied by four 12-cylinder, 250 horse-power motors. An auxiliary motor will be provided to drive a screw propeller, so that the craft can be navigated at slow speeds on the surface of the water.—*Scientific American.*

Japan to Build Ten Aeroplane Motors for Russia.—An order has recently been placed at the Koishikawa Arsenal by Russia for the manufacture of ten aeroplane motors. The authorities have accepted it, it is understood, although recently an order for 300 planes from Petrograd was declined by them owing to the limited productive capacity of the Arsenal.

Some twenty motors, all of 70 h.p. type, have been manufactured by the Koishikawa Arsenal for the Army Air Service. Since the outbreak of the European war, the staff members of the Arsenal have been working to produce a more efficient engine. Their labor has recently been rewarded by the successful manufacture of a 100 h.p. motor. It will shortly be tried at Tokorozawa Aerodrome.

A new waterplane with a 200 h.p. motor has been added to the Navy

Flying Corps. It has been manufactured by the Naval Arsenal at Nagaura entirely with Japanese materials. Flight-Lieut. Inouye, of the Navy, has tried the gliding power of the new machine at Oppama successfully and he is expected shortly to make a flight on it.

In observance of the anniversary of the founding of the Empire and also in celebration of the anniversary of a magazine, Juichi Sakamoto, an aviator, was to have made some flights at Tokio, on Feb. 11. In this connection the Nikoniko Club advertised for women candidates who would go up on an aerial excursion with Mr. Sakamoto. The Club received 30 applications. Six of them were accepted, and they will be absolutely the first women to go up in the air in Japan. Their ages range from 20 to 24, and they are all daughters of respectable people. The event is expected to start in this country a new vogue of flight for women, but in trying out the engines on the appointed day the engines suddenly stopped at a height of 100 meters and the machine fell into a tree and was wrecked. The first flight of women in Japan was therefore postponed. The aviator escaped without injury.—*Aerial Age Weekly.*

An Aerial Ambulance, it is reported, is being built by a California manufacturer, and army aviators at San Diego, Cal., have been permitted to see it. Under the body of the aeroplane is slung a small cot, which is so fastened and constructed that it will be impossible for the occupant to fall out or even be shaken when the aeroplane volplanes to earth. It is understood that while the craft is enroute to the hospital a trained attendant will be enabled to give first aid to the patient.—*Scientific American.*

American Naval Gunnery.—Testifying before a congressional committee, Admiral Fletcher gave it as his opinion that from 10 to 20 per cent of the shots fired from an American battleship would land on an enemy at 18,000 yards, this estimate being based on the recent target practice at Guantanamo. He stated that his flagship, the *Wyoming*, in target work at 12,000 yards had put three 12-inch shells through a 10-inch armor plate.
—*Scientific American.*

Trials of Our Latest Dreadnought.—The *Pennsylvania*, our first ship to carry twelve 14-inch guns, recently went through her high-speed trials satisfactorily, averaging for some hours one-half a knot above her contract speed of 21 knots. In gun power, and particularly in armor, the *Pennsylvania* may be considered to outmatch the latest dreadnoughts of other powers; but her speed, having in mind what the other people are doing, is lamentably low; in proof of which consider the 25-knot British *Queen Elizabeth*, the 23-knot Russian *Gongort*, and the 22.5-knot Italian *Caio Duillio.*
—*Scientific American.*

Increase in Battleship Size.—Not only is the United States building battleships of great displacement, as witness our *Pennsylvania* of 31,400 tons, but the other nations, with the exception of Great Britain, are keeping well abreast of us in this respect. Thus, the Russian Navy is completing this year four battle-cruisers of 32,200 tons. Japan has in commission her 30,600-ton battleship *Fuso*, and she is building three others, due to go in commission this year and next, of 31,300 tons. Italy will complete next year four battleships of 30,000 tons displacement, and Germany, it is be-

lieved, has completed since the war began three ships of close to 30,000 tons. The Japanese ships are to have a speed of 22.5 knots; the German, 23 knots; the Italian battleships, 25 knots, and the Russian battle-cruisers, 25½ knots.—*Scientific American.*

Should Ships Carry Howitzers? By a Land Gunner.—At the Dardanelles the *Queen Elizabeth,* firing over the peninsula destroyed a Turkish bridge of boats with a 15-inch gun, firing at about 17 degrees elevation. The latest British naval guns are capable of 20 degrees elevation, the German naval guns of 30 degrees. It is now recognized that howitzers are necessary to supplement guns for coast defense, as they attack a weaker part of the target than the guns—namely, the deck—and can therefore take on ships at which the guns are ineffective. On the same principle, a ship should carry howitzers. But owing to the rolling and pitching of the ship, it is not easy to hit anything with a howitzer, even if fired at the moment that the deck is horizontal. The author goes into elaborate calculations concerning the angle and rate of roll, and concludes that the expenditure of howitzer ammunition necessary to hit a battleship would be prohibitive, and that, until a stable mounting can be devised, ships should not carry howitzers.—Extracts from *Précis of Artilleristische Monatshefte* in *Proceedings of the U. S. Naval Institute.*

Direct and High-Angle Fire. By Lieut. General Rohne.—At 45 degrees, and a few degrees above and below this elevation, the shooting of a howitzer is wild, and therefore shooting at the higher angles should be undertaken from 50 degrees upwards. At 65 degrees some of the shell fall base first, while at 75 degrees they all fall base first, giving very irregular shooting. Therefore the practical limits for high-angle fire are between 50 and 65 degrees of elevation. General Rohne reckons that the lateral dispersion is in direct proportion to the time of flight, that is, about double the dispersion with direct fire; the dispersion in depth is, however, not much greater. The striking velocity is much the same as with direct fire, but the penetration against a horizontal target is from 2 to 5 times as much as with direct fire. Therefore for penetration it pays to use high-angle fire at over 50 degrees elevation, while for accuracy it pays to use the lowest elevation that will reach the target.—Extracts from *Précis of Artilleristische Monatshefte* in *Proceedings of the U. S. Naval Institute.*

"E-2" Submarine Explosion.—The Navy Department has issued a statement relative to the explosion of the submarine *E-2* at the New York Navy Yard, which killed four men and injured 12 more. The conclusions reached by the board of investigation is that "the explosion was due to an excessive amount of gas; namely, hydrogen, generated from the storage batteries, forming with the air a high explosive mixture. That there were two pockets of this mixture, one at the after end of the after battery and the other at the forward end of the forward battery, and it appears that the initial explosion occurred at the after end of the after battery." The ignition was caused by a spark, the origin of which the board is unable to determine. "The condition of the batteries at the low voltage and amperage, 82 and 940, respectively, at about 12:25 P. M. would probably cause a reversal of voltage in some of the cells, and, in the opinion of the board, this caused the generation of an excessive amount of hydrogen gas."

The *E-2* was fitted with the new Edison storage battery designed to eliminate the formation of chlorine gas during submergence. The Edison battery for submarines is nickel-iron-alkali type, composed of nickel, iron oxide and steel in a solution of potash. The potash acts as a preservative of all the combined elements, so that the battery elements do not destroy each other. The theory of it is this: The submarine is steel and floats in an alkaline solution of water. The battery is steel and contains an alkaline solution, so that the cause for the generation of chlorine gas does not exist. Following a series of exhaustive tests of every conceivable kind, a set of the new batteries was installed in the *E-2* last summer. The first official trial of the batteries in the *E-2* was made November 11, when the *E-2*, equipped with the Edison cells, made a trip up Long Island Sound. In an unofficial test a few weeks earlier it was reported that the *E-2* had done thirteen knots an hour for three and a half hours while submerged. The *E-2* is four years old and of the Holland type.—From *Shipping Illustrated* in *Proceedings of the U. S. Naval Institute.*

Electrolyte for Pocket Lamp Batteries.—The following instructions are given in a German publication for preparing the electrolyte used in the batteries for the ordinary pocket flash lamp:

One hundred and forty grammes of well-powdered salammoniac, 40 grammes of zinc chloride, 10 grammes of ammonium sulphate are mixed together in a porcelain bowl with 10 grammes of thick refined glycerine. The mixture is then covered in small quantities with distilled water at a temperature of 40 deg. Cent. and energetically stirred until the materials are dissolved into a concentrated solution. This mixture is allowed to soak into the binding material, and the paste so formed is filled into the cells, which are closed with a paraffined card top sealed with bottle-wax. In the cover two small glass tubes are provided for the escape of such gases as are generated within the cell. In compounding the electrolyte calcium acetate can be mixed with advantage with equal parts of the salammoniac. Such a solution possesses excellent conductivity, is hygroscopic, and does not crystallize or creep.

Binding materials used for making a paste of the electrolyte are glass-wool, sawdust, gelatine, starch, kieselguhr and water-glass. Ordinary flour, either wheat or rye, is, however, most generally used.

—*Scientific American Supplement.*

A Dry Storage Battery of the same size and shape as the ordinary dry cell is an offering of an American manufacturer. The new storage battery contains a non-flowing electrolyte and, according to the statements of the manufacturer, can be recharged an infinite number of times at a lower price per charge than the original cost of an ordinary dry cell. The rating of the battery is 0.5 ampere for 40 hours, 1 ampere for 18 hours, 2 amperes for eight hours, or 3 amperes for five hours. The average discharge potential is 2 volts. The container of the battery is made of unbreakable paper-fiber, while the elements are of rolled strips of corrugated lead. The electrolyte is contained in an amorphous, non-crystallizing white substance which is claimed to possess exceptionally high absorbing power. A tube is provided in the center of the cell for carrying water in order to prevent the cell from drying out.—*Scientific American.*

Compass that Indicates the Time.—By a slight modification in the ordinary pocket compass it has been transformed into a very practical timepiece for indicating the hour by the shadow of the sun. In addition to the usual "points," there is a graduated hour scale with the two twelves at the North and South. The crystal by which the magnetic needle is protected has a line stretched across it through the center and it is mounted in a bezel which permits of the glass being rotatably moved. Knowing the variation of the compass, an adjustment of the glass is made to overcome it, the etched line forming an angle with the North and South line corresponding with the variation. The instrument being held horizontally and the etched line being directed against the sun, the time is indicated by the needle, the point of which overhangs the graduated hour scale.

—*Scientific American.*

Notices

We desire to congratulate the management of *The Military Surgeon* on its late issues.

The re-organization recently effected has produced a publication, not only very attractive in form but containing matter that is both most interesting and instructive.

The JOURNAL OF THE U. S. ARTILLERY endorses the statement that the new *Military Surgeon* is a fitting exponent of the able, progressive, and powerful organization which it represents, and as deserving of every confidence and support.

Attention is invited to change in address of the main office of the Goldschmidt Thermit Company to The Equitable Building, 120 Broadway, New York City.

For the benefit of our Coast Artillery readers during the present service practice season, we invite attention to the Elliott Ear Protector advertised on page xii.

In its present form, the device is apparently most excellent.

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BOOK REVIEWS

Mahon: Base Naval Avanzada. (Su significacion y artillado como capitalidad militar y maritima de las Baleares.) By D. Francisco A. de Cienfuegos, Capitan de Artilleria. Mahon, Spain: M. Sintes Rotger, Plaza del Principle, 11. 6" x 8¼". 147 pp. 1915. Paper. Price, 3 fr.

This book on the value of Mahon, on the Island of Minorca, Spain, as an advanced naval base and its fortification as the headquarters of the Military and Naval forces of the Balearic Islands, consists of several parts:

1st. A Prologue by Senor Don Antonio Victory, the President of the Athenaeum before which the Monograph, mentioned below, was read.

2nd. The Preamble by Don Antonio Padro, Captain of Artillery, Spanish Army, who read the Monograph to the Athenaeum in the absence of its author, Don Francisco A. de Cienfuegos, Captain of Artillery, Spanish Army.

3rd. The Monograph itself in four chapters with an attached provisional organization for the fortification for an advanced naval base of the island of Minorca and its capital, Mahon.

4th. The Epilogue by Don Padro M. Cardona, Lieutenant, Spanish Navy.

The Prologue is an admirable study of the strategical value of principal and advanced naval bases, referring particularly to the control by Spain of the western part of the Mediterranean Sea. Mahon, the capital of Minorca, is advocated as the more eastern advanced base of Spain, in this sea, in spite of the paucity of resources of the island upon which it is situated, on account of its harbor which has a narrow entrance. It is thought in the light of experience gained by the present war in Europe, this fact would be great advantage for such a base, owing to its being more adapted to defense against submarine attacks than a more open harbor. This narrow entrance and its shallowness were some of the principal defects urged by its opponents heretofore. The latter defect can be remedied and the former is now considered a distinct advantage.

It is stated that the Mediterranean Sea, always most important in the past will become more so in the future from a standpoint of naval supremacy, due to the inevitable readjustment of the equilibrium of sea power from northern seas, resulting from the present war and particularly to the rapid colonization of North Africa by maritime powers that will be further increased as the resources, practically yet untouched, of Africa itself are developed.

The value of an advanced base is categorically stated to depend on its nearness to the possible theater of action or of the fleet operating from it, thus reducing the time element of striking the enemy.

Mahon is practically astride the French line of water communication between France and Algeria and its naval strategical line Toulon and Bizerta,

in one direction; and of the naval strategical line of England between her two principal bases, Gibralter and Malta, in the other direction. In the event of hostilities, it is feared that Mahon would be seized by other powers, to whose lines of communication it would be a serious menace. Its capture by any maritime power would in turn menace the Spanish coast and destroy its control of this part of the Mediterranean Sea. As a base of operations for submarines Mahon is considered ideally situated and in conclusion it is stated again the absolute necessity of Spain to hold Minorca at any cost.

The Preamble consists of complimentary allusions to the distinguished author of the Monograph itself which is read to Athenaeum by another author of note, Captain Padro, Spanish Artillery, who holds the same views as these stated in the Monograph.

The Monograph, "Mahon, Naval Base Avanzada," is a deeply considered, well thought out and very complete study of naval strategy in regard to the selection of principal and advanced bases.

The foremost advantages, outweighing all others, are those of position and assurance from landward attacks. Mahon, in spite of its disadvantages, is considered almost ideally situated not only from its position, eminently strategical, but from the fact of being an island readily capable of a strong defense.

The opinions given are upheld by allusions to bases of the great maritime powers, particularly of Malta, which is considered an ideal naval base situated on a small island. These opinions are still further strengthened by copious extracts from authors of note on the subjects of seapower and naval strategy. Proper permanent defenses for naval bases are advocated so that the naval power has extreme freedom of action as an offensive arm, without being under the necessity of considering the defense of its base, which must be strong enough to defend itself. Bernhardi is quoted and Heligoland is cited as an example.

Following the lessons of the present war and the usage of the foremost military powers it is demanded, very properly, powerful guns of great caliber and range for the primary armament for the projected naval base, Mahon. It is also advocated that the caliber of the primary armament of the base should be the same as that of the ships of the fleet, if for no other reason than interchangeability of ammunition. The use of mortars, except on land fronts, and to cover anchorages is not advocated owing to the fallacious opinion of their inaccuracy of fire due to the time of flight and the consequent movement of the target and instrumental range finding errors. Calibers of intermediate armament to be increased owing to increase in armor and guns of their objective. Fire control is stated to be as important as the ammunition supply or the guns themselves. The installation is advocated of horizontal bases properly placed and most strongly protected from fire for the primary armament, actuating automatic range indicators on the guns themselves. The same automatic control, details not given, to be applied to the searchlights. For mortar or howitzer and the intermediate armament, a separate range finder device for each battery only, with a preference for a vertical base installation. All electric communication by subterranean cable. Adequate protection, even to the extent of armor, is strongly urged for all range finding, telephone, and fire control stations, as it is stated, a coast artilleryman, different from other arms, can only receive his baptism of fire usually once and in a short and terrific period of fire and should be always intensively trained and furthermore

absolutely protected from hostile fire to which he will not have the opportunity to reply. In other words his opportunity comes usually but once with its success or failure, while other arms have many opportunities to become seasoned where not such tremendous results are at stake.

Nets should be provided as a defense against submarines and guns, specially designed for use against aeroplanes and dirigibles.

Strongly fortified ports, bases, and strategical waters will be avoided usually and efforts to make landings at unfortified nearby landing places and attack of the fortifications by land will usually obtain.

For coast defense in its broadest sense and against attempted landings in great or less force, mobile defense guns with automobile or train transport, which is possible without prohibitive cost, is advocated, where permanent defenses are not projected. These trains of mobile guns completely equipped for instant action to be held at some interior central base ready to proceed to any threatened point or points, as several attempts or feints will usually be made simultaneously.

In conclusion, it is stated that bases and fortifications should be few in number, adequately fortified and equipped, in distinction to many such with provisional installations, especially for a country as poor in resources as Spain.

After a rather full discussion of the fortification and armament of naval bases, primary and secondary havens and coaling stations, the author leads up to the importance, in his opinion, which seems well taken, of the urgent necessity of the establishment, at once, of an advanced naval base of the first importance heavily fortified, as outlined in a defensive scheme of armament, aeroplane and land defense and fire control and searchlight organizations, that are entirely of Spanish local interest, at Mahon, in Minorca. Thus making this place the center of naval and military activity in the Balearic Islands. This port is considered by him as the strategical point of the greatest importance in the control of sea power in the western part of the Mediterranean Sea not excepting Gibralter itself.

In the Epilogue, a very general review of the Monograph is made with references to the authorities cited and an academic and political discussion of the situation that exists in this portion of the Mediterranean Sea and the entire agreement as a naval officer with the ideas expressed with regard to the importance of Mahon. Recommendation is made that Mahon, Minorca, be decreed a free port for the purpose of establishing there a large amount of commercial stores and supplies that would be available for supplying the garrison and base in time of war, should the country be too poor to fully equip this isolated advanced base.

Abundant supply of water at Mahon, a point not hitherto mentioned, is dwelt upon at considerable length, as its great and usually underestimated importance demands and in conclusion nominates the author of the Monograph for honorary membership in the Atheneaum.

♣ ♣ ♣

A Mechanistic View of War and Peace. By George W. Crile. New York: The Macmillan Company, 64 Fifth Avenue. 5¾" x 8". 105 pp. 32 il. 1915. Cloth. Price, $1.25.

This book is from the pen of the distinguished American surgeon, Dr. George W. Crile, of Cleveland, who was for a time in charge of a hospital

unit of the American Ambulance at Neuilly, France. Original observations are made upon the behavior of fighting men on the battlefield and in the hospital, of prisoners of war, of refuges and of non-combatants at home. He describes trench fighting, artillery fire, waiting under fire, sleep, dreams, pain, courage, etc., with reference to the mental and more particularly the emotional aspects. The interpretation of these phenomena is sought in the principles of evolution and in the mechanistic view of the structure and functions of the human body. This book might therefore be fittingly entitled "The Psychology of War from a Mechanistic Viewpoint."

One of the first principles of animal action is that given a certain structural organization, a definite stimulus will produce an invariable mechanical result. For example, rays of light striking the retina produce contraction of the pupil. This has been called innate behavior and is due to an inherited mechanism or action pattern in the nervous system. During the long progress in the development of man from lower forms the controlling influence, as Dr. Crile shows, has been physical struggle, the "struggle for existence," tooth and nail fighting between beasts, contest between man and beast and combat between man and man for food, for mates, and for life itself. The action patterns for combat which have been thus formed are dominant since they have been implanted by inheritance in the brains of countless generations of man and beast and have been re-enforced and strengthened by the fighting experiences of all animals and of every generation of man. Granting therefore that behavior depends in fundamental characteristics upon pre-formed action patterns in the brain, the environment of war-preparation and of actual battle furnish the necessary stimulus to produce the "phenomena of war."

In the attack on Belgium by Germany, Dr. Crile shows that in addition to the bodily damage caused by bullets, bayonets, and assault, the emotional strain suffered by the entire population even produced greater physical injury. It is well known that under the stress of the primitive emotions such as fear and rage, definite physical changes are produced in many of the important organs and tissues of the body. From this point of view are explained the many sudden deaths, the many cases of insomina, of neurasthenia, of prostration; of children prematurely born in the streets, in railway stations or on trains; of suicides, of children and adults becoming insane. He adds, "The Belgian exiles whom I have seen show a loss of morale; they are preoccupied, absent-minded, diseased, homesick, dejected, bitter and broken."

The author suggests that war may be eliminated by substituting in man's brain the action patterns of peace for those of combat through the influences of education and training. A new philosophy he says must be introduced and children taught the disadvantages of war as well as its advantages. The greatest talent in the country should be found not at the head of armies or strategy boards, not in finance or industry, but at the head of state educational institutions.

This remarkable book presents, we believe, one of the strongest arguments for belief in the continuance of war as a human institution. Warfare is the expression of an elemental and vital force in man's nature, the instinct of combat. This impulse is essential in animals and primitive man as a means of self-preservation. Among both animals and man, fighting is attended with the expression of the great primitive emotions, indeed it is probable that the emotions of anger and fear have been developed as mechanisms by which fighting powers are increased and made more efficient.

The instilling of altruistic ideals through education and training may diminish the frequency of war, but that these forces can ever effectually control or prevent war may be doubted on biological grounds. These traits are in the nature of acquired characteristics and are according to well known biological laws not transmissible. Furthermore, bodily reactions in the presence of emotion-provoking objects are often beyond the control of the will. It would seem therefore improbable that a primitive instinct, as that of combat, attended with the elemental emotions of anger and fear, could be controlled or displaced by characteristics recently acquired.

If, as Dr. Crile believes, "the civilization of today cannot prevent war because under existing conditions war is inevitable," then the moral for this generation is clear,—"Preparedness."

♦ ♦ ♦

West Point in Our Next War. By Maxwell Van Zandt Woodhull, A. M., late Lieut. Col. and A. A. G. 15th Army Corps, and Bvt. Brig. Gen. U. S. V. New York City: G. P. Putnam's Sons, 2 West 45th St. 5½" x 7¾". 266 pp. Cloth. 1915. Price, $1.25.

This book is very interesting and instructive as coming from a man, who, not being a graduate of the Military Academy, never having served in the regular army, and on the other hand having entered the Civil War as a Captain of Volunteers, and served with conspicuous gallantry and efficiency to the end, contends that the day of volunteer armies has passed; that all troops should be raised by conscription; and that the officers should be appointed exclusively from graduates of West Point.

In order to accomplish the latter he proposes to increase the Corps of Cadets to 3600, graduating half of them into the reserve at the end of two years, and retaining the balance for a post graduate course and entry into the active army.

Among his many radical suggestions supported by argument based upon much experience and well-digested study, are the following:

A garrison of 150,000 men for the Canal Zone and corresponding numbers for Hawaii and Alaska.

The abandonment of all attempt to defend the Philippine Islands, and their outright sale to Germany.

The maintenance at home in time of peace of no infantry whatever, all existing regiments to be converted into cavalry and field artillery. Infantry training to be given to all arms by detailing organizations to serve as such for periods of one year at a time, the peace strength of the artillery and cavalry to be the proper war strength of an army of a million men.

He thinks the militia undependable and is opposed to its federalization. He thinks Secretary Garrison's continental army impracticable. He says the raising and maintenance of federal volunteers in time of peace, as proposed by General Carter, is visionary in the extreme, and as impossible of realization as "to maintain a rose garden at the North Pole." He thinks military camps for civilians do no good unless it convinces the participants that soldiers cannot be made in that way.

He objects to the Swiss system and to the Australian system on the grounds that they are based partially upon the volunteer idea. He says, "Let us bravely face the truth that the time has passed for the employment of volunteers in war, * * * and accept the necessary and inevitable

policy of conscription, * * * the most democratic, fairest, and the most equal, and the only logical method of raising modern armies."

He objects to all plans of territorializing the army, as opposed to a public policy and tending to create a Massachusetts army, a South Carolina army, etc., instead of a United States army.

He says that the Organization Tables of the War College are based upon theoretical study of officers who have had no experience in war. He advocates a return to the principles of strategy and tactics as developed by the great leaders of the Civil War, especially as to the use of cavalry and artillery. He draws comparisons with the war in Europe and shows that the fundamental principles are unchanged. He supports Lieutenant-General Bates in the view that an infantry company should not exceed 107 men. He thinks the regiments and brigades are too large, and that the division should not have supplanted the army corps as developed in the Civil War.

He advocates a full relief of Coast Artillery for the seacoast defenses, more and heavier field artillery, more machine guns, more motor transportation, and more aeroplanes.

His plan for increasing the Corps of Cadets to 3600 involves such a complete reorganization of the whole institution that it would undoubtedly meet strong opposition. He proposes to organize the Corps into a Brigade, and to devote much time to a class of instruction now reserved to the Service Schools. He would change the method of appointment. He would change the curriculum. He would relieve all officer instructors and replace them by civilians, and would change the disposition to be made of Cadets upon graduation. His plan raises the issue as to whether it would be better to have a small percentage of officers graduated from the old West Point and the rest appointed from civil life and the ranks, or to have all officers graduated from the new West Point, similar to the old one in name only.

The book is well worth reading, and puts a big question mark after many of the present-day fads and fancies of military organization in the United States.

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Military Topography and Photography. By Lieut. F. D. Carlock, U. S. Infantry. Menasha, Wisconsin: Geo. Banta Publishing Company. 6" x 9¼". 310 pp. 122 il. Cloth. 1916. Price, $2.50.

This book is intended as a guide and reference book for those engaged in military topographical work. There are five chapters covering military map reading, topographical surveying, military sketching, photography, and special problems; and one chapter containing a reprint of "Conventional Signs United States Army Maps" (U. S. Geological Survey), tables of conversion, trigonometric formulæ, logarithms of numbers, stadia reductions, and polyconic projections.

Chaper I is devoted to a discussion of the various kinds of military and topographical maps, scales, method of orientation, location of map's position, visibility, and map interpretation.

The second chapter covers topographical surveying. Under this heading, the author discusses geodetic operations, so as to enable the military topographer to take advantage of available geodetic information; control work; the plane table; sketching methods; and photo-topographical operations.

Under the heading, military sketching, the author discusses measuring and plotting direction, distances and slopes; plotting character of terrain; classes of sketches; kinds of sketching; and the general principles of rapid sketching.

The chapter on photography is particularly interesting on account of the extent to which photography is used in recording military and topographical information. The various kinds of cameras and their utility, the optical principles of lenses, shutters and other photographic accessories, and developing and printing processes, are discussed thoroughly and in such a way that even a novice in photography, who has topographic work to do, should be enabled to make good use of photographic apparatus as an aid in his work.

The chapter on special problems covers, among other things, the adjustments and use of the various surveying instruments; traverses; base line measurement; methods of azimuth determination; use of the solar attachment in the determination of latitude, longitude, and azimuth. The various kinds of field notes and computations are clearly illustrated and explained by examples.

In his preface, the author states that it has been his aim to present the different subjects and their expositions in a logical, clear, and precise way, and, at the same time, the whole subject completely and comprehensively. In this he has succeeded and, by way of making his book even more convenient, has appended a good index.

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Roadside Glimpses of the Great War. By Arthur Sweetser. New York City: The Macmillan Company, 64 Fifth Avenue. 5½" x 7¾". 272 pp. 9 il. Cloth. 1916. Price, $1.25.

The author, a Boston newspaper correspondent, starts for Europe on the day war is declared. He crosses to London, from there to Paris from whence he bicycles out to meet Von Kluck with whose troops he travels for several days. Upon the turning back of the Germans, he permits himself to be left behind and rejoins the French, getting glimpses of the battle at the Aisne. He later visits the Belgians and manages to again make observations on both sides of the line.

Throughout his adventures, Mr. Sweetser frequently observes a lack of cordiality on the part of his involuntary hosts. However, he bears a charmed life and rides a charmed bicycle which rediscovers itself after every loss. His view of the war is best described by the title he has chosen, "roadside glimpses." What he has seen he describes with the clearness and definition of a sharp focused snap shot, and in general spares us romancing and moralizing. He sees the War as the villager, peasant, and soldier in ranks sees it, and describes it with less hysteria and greater sanity than his introductory pages would lead us to expect.

His observations as to "atrocities" are well worth examination and confirm the belief that these fall into two classes: the stern punishment of hostile acts committed by the civil population, and sporadic crimes by lawless individuals who take advantage of the disturbed conditions and the helplessness of the subject population.

The book is well worth a casual reading and the reader will be both interested and instructed.

First Aid in Emergencies. By E. L. Eliason, M. D. Philadelphia, Penn.: J. B. Lippincott Company, East Washington Square. 4½" x 7". 204 pp. 106 il. Cloth. 1916. Price, $1.50.

This book contains a chapter under each of the following headings: General Considerations; Surgical Principles and Supply; Wounds; Hemorrhage (Bleeding); Heat and Cold Effects; Sprains, Dislocations, and Fractures; Unconscious Conditions and Fits or Convulsions; Suffocation; Poisons; and Medical Emergencies.

Each subject is treated in a clear, well thought out manner with numerous illustrations.

It is not intended for physicians or medical students nor as a technical and scientific treatise, but it undoubtedly is what the author claims it to be—"a help to humanity in general to meet and treat the ordinary emergencies that arise in everyday life."

While it is intended to prescribe the methods to be adopted until the arrival of a physician, the information given is so complete that patients can be well taken care of in isolated localities where medical aid is not obtainable.

It is a book that should be in every household and it would also be of great value to members of a police force and to company officers as an additional aid to them in instructing soldiers in first aid methods.

The book is of convenient size, clearly printed and well bound; and, as it contains a "thumb index," any desired subject is immediately available.

♣ ♣ ♣

Criticisms Upon Solutions of Map Problems Given Out at the Army School of the Line. By Captain C. T. Boyd, 10th U. S. Cavalry. Menasha, Wisconsin: George Banta Publishing Company. 6¼"x9¼". 284 pp. 3 il. 1915. Cloth. Price, $2.00.

The author has compiled a series of map problems given out at the Army School of the Line, including a brief statement of a number of solutions of each problem by student officers and the instructors' criticisms thereon. The extracts of solutions and comments have been carefully selected to emphasize the tactical lessons that each problem is intended to illustrate, and by means of the comments to bring to attention many common errors made in the solutions of map problems.

The work includes six problems involving less than one regiment, and ten brigade problems, all being on the Gettysburg-Antietam Map.

For the officer who wishes to improve himself in minor tactics, and for instructors and student officers in the garrison school, this book fills a long felt want; as the student can find many instructors' comments that will apply to his solution of the problem, and in each case the approved solution is given in full for a final study and comparison.

This work should be in the library of every progressive officer in all arms of the service.

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Examples in Magnetism. By Prof. F. E. Austin, Box 441, Hanover, N. H. 5" x 7½". 90 pp. 27 il. 1916. Flexible leather. Price, $1.10.

Professor Austin's book *Examples in Magnetism* is an excellent treatment of the quantitative study of an existing magnetic field. After a few comments on the nature of magnetism, not including the induction of such

fields nor the laws of magnetic circuits, the author confines himself to concrete problems involving the reactions of a field already established upon permanent magnets of known strength. No elaborate derivations of formulas are undertaken, and the few mathematical discussions required are brief, definite, and clear.

Aside from its value as a student's text, this book should be of particular value to electrical engineers who have through lapse of time become unfamiliar with the units of magnetic measurement. These units and their relation to each other are explained with unusual clearness, and careful distinction made between such units as the gauss and the maxwell, which are so easily confused by anyone save the few who habitually use them.

Terrestial magnetism is dwelt upon in great detail, and each principle involved is illustrated by painstaking solutions.

In addition to the above, the book contains a review of trigonometry, a syllabus of statical mechanics, tables of conversion from English to metric units and from fractions to decimals, and an abridged set of angle-tables—all of which are contained in ampler form in texts and handbooks accessible to every engineer or technical student. As this is not a pocketbook for use in the field, it is to be regretted that this space was so utilized to the exclusion of other more nearly related material, such as an elaboration of the excellent but very abbreviated discussion of the attraction of iron by magnets.

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Apuntes para la Instruccion Tactica de los Sub-Officiales de Infanteria. By A. Uribe G., Mayor de Ingenieros. 4¾" x 6½". 188 pp. Paper. 1915.

This is an interesting, well written book of undoubted value. The author has divided his subject in a very logical manner, and discusses the various chapters clearly and in a style to be easily understood.

In the first few pages is a general description of the manner of stating solutions, method of discussing the various phases, and of the usual duties of the different arms to be discussed.

Then follows a series of chapters on uses of infantry, dealing with the various formations used, marches, conditions affecting health, water, camps, etc., and the different cases arising in the service of security and information. Much attention has evidently been given to the important subject of security and information, and the author is to be complimented on his simple yet thorough discussion of the subject, which can easily be understood by non-commissioned officers. Difficult discussions are not presented, still it is complete as dealing with the conditions when near the enemy and when in immediate contact with him.

A number of chapters is next devoted to the subject of combat, including a general discussion, and a very thorough discussion of the uses of the platoon and squad in the different classes of combat.

Short chapters on uses of infantry against other arms, sanitation and methods of supply complete the little book which seems to be of inestimable value in the education of the non-commissioned officer.

The subjects presented, if carefully studied, cannot fail to be understood, and having been grasped, the non-commissioned officer has at his disposal information complete enough to make him a valuable leader and yet not elaborate enough to confuse him.

The Writing on the Wall. The Nation on Trial. By Eric Fisher Wood. New York: The Century Company, 353 Fourth Avenue. 5" x 7". 206 pp. 11 il. Cloth. 1916. Price, $1.00.

This little book is an excellent sermon on preparedness, based upon a statement of our military weakness and the lessons of the war in Europe. It is short enough to be read at a sitting, and the subject is presented in a manner calculated to interest the civilian reader.

The author, who is a graduate of Yale, was a student in Paris at the outbreak of the war, and was assigned to duty at the American Embassy. He had unusual opportunities to witness the mobilization of the French army and to visit the battlefields in France. The results of his observations were embodied in "A Notebook of an Attaché," a book which has attracted wide notice, in reports to the Army War College, and in several lectures to Army officers.

In the present volume, he presents the conclusions which he drew from his observations, and applies them to the military problems of the United States. His conclusions and the defensive plan outlined were submitted by him to the judgment of Army and Navy officers, and were revised in accordance with their advice. To quote from the "Publisher's Note" at the beginning of the book, "He acts as unofficial spokesman for our professional military authorities, who have much of vital interest to tell us about military preparedness, but are prevented from speaking for themselves by a political censorship more vigorous than the military one now maintained in Europe."

After a brief allusion to the lessons of our military history, the author points out our liability to attack, and gives the General Staff estimate of the number of troops that could be landed in a short time by possible enemies. From this he estimates that we shall need 500,000 trained soldiers in two weeks, and 2,500,000 two months later. He proposes to meet this need by universal military service based on the Swiss and Australian systems. The value of such systems is discussed from the educational and economic, as well as military, standpoint. Secretary Garrison's plan for a volunteer continental army is dismissed as impractical, and for the reason that it is founded on false principles, for, as the author says, "It is not only the right but the duty of every citizen to defend his country."

The naval policy of the Administration is characterized as an attempt to befog the issue by spreading the building program over a number of years, thus making it appear that the rate of naval increase is to be accelerated, whereas it is, in fact, merely "the perpetuation for eight years to come of the totally inadequate rate of increase of the last decade."


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